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Founded by HENRY BALDWIN WARD

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Copies of this Section will be available at University Park

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THE JOURNAL OF PARASITOLOGY

The Journal of Parasitology, published bi-monthly, is both the official organ of the American Society of Parasitologists and a medium for the publication of the results of research in the field of animal parasitology.

Manuscripts intended for publication may be sent to the Editor or any other member of the Editorial Board with the understanding that they are to be published exclusively in the Journal unless otherwise arranged in advance. All papers received will be submitted to competent reviewers, either members of the Board or other persons with special qualifications. Authors will be notified when their papers have been accepted for publication. Correspondence regarding manuscripts should be addressed to the Editor (address above).

Manuscripts should be typewritten, double-spaced, with wide margins at sides, top and bottom, and with tables and illustrations in finished form. Sentences should be concise and clear, and the text should be as condensed as possible because of mounting costs of publication. Title, author, address, etc., as well as footnotes, should appear on a separate sheet. Footnotes should be avoided whenever possible. Each table requires a separate sheet. Tables should be simple, since complex ones are difficult to inspect.

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The Journal of Parasitology

Vol. 45, No. 4, Section 2 (Supplement) August, 1959

PROGRAM AND ABSTRACTS OF THE THIRTY-FOURTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS

UNIVERSITY PARK, PENNSYLVANIA

August 30–September 2, 1959

NOTE: Registration: In Hetzel Union Building, Lobby, from Sunday through Wednesday. Get luncheon tickets at time of registration.

PROGRAM[1]

SUNDAY AFTERNOON, AUGUST 30, 2:00 P.M., CONFERENCE CENTER LOUNGE.
COUNCIL MEETING, OFFICERS AND MEMBERS OF THE SOCIETY'S COUNCIL.
(An evening session, if necessary, will convene at 7:30 P.M. in the same room. All Past President of the Society are cordially invited to attend all sessions of the Council.)

Monday Morning Session A, August 31, 9:00 A.M.
Room 110, Electrical Engineering Building
Aurel O. Foster, Agricultural Research Service, PRESIDING

Read

(Authors are requested to keep within the time limits indicated for each paper)

1. Progenetic maturity and phylogeny of digenetic trematodes. (10 min.) (Standard lantern). **H. W. Stunkard,** U. S. Fish and Wildlife Service and American Museum of Natural History, New York, N. Y.

2. Chromosomes of schistosomes. (10 min.) (Standard lantern). **R. B. Short** and **M. Y. Menzel,** Florida State University, Tallahassee, Florida.

3. Inhibition of development of cercariae of *Schistosoma mansoni* following ultra-violet irradiation. (10 min.) (2×2 lantern). **O. D. Standen,** Wellcome Laboratories of Tropical Medicine, London, England. (Introduced by Paul E. Thompson).

4. Stimulation of *Schistosomatium douthitti* cercariae to penetrate their host. (10 min.) (Standard lantern). **A. Wagner,** Florida State University, Tallahassee, Florida.

[1] An alphabetical author-index will be found at the end of this section of the program. Extra copies of this supplement will be on sale at the meeting.

5. Comparative glandular equipment of the human schistosomes. (10 min.) (2×2 lantern). **M. A. Stirewalt,** Naval Medical School and Naval Medical Research Institute, Bethesda, Maryland.

6. Observations on the humoral and cellular basis of resistance to *Schistosoma japonicum.* (15 min.) (2×2 lantern). **E. H. Sadun** and **S. S. Lin,** Walter Reed Army Institute of Research, Washington 12, D. C. and 406 Medical General Laboratory, Japan.

7. The behavior of different geographic strains of *Schistosoma japonicum* in circumoval test. (15 min.) (Standard lantern). **S. Y. Li Hsü** and **H. F. Hsü,** State University of Iowa, Iowa City, Iowa.

8. Studies on schistosomiasis XIV. Effects of cortisone upon the *Schistosoma mansoni* burden in mice. (12 min.) (Standard lantern). **C. J. Weinman** and **G. W. Hunter III,** University of Florida, Gainesville, Florida.

9. The influence of very low concentrations of sodium pentachlorophenate upon the fecundity and egg viability of *Australorbis glabratus.* (12 min.) (Standard lantern). **L. Olivier** and **W. T. Haskins,** National Institutes of Health, Bethesda 14, Maryland.

10. Electrophoretic studies of the sera of white rats and cats following infection with *Paragonimus kellicotti* Ward, 1908. (15 min.) (Standard lantern). **F. J. Kruidenier** and **A. K. Katoh,** University of Illinois, Urbana, Illinois.

11. Ultrastructure of the surface layers of a strigeid metacercaria, *Diplostomulum trituri* and an echinostome cercaria, *Himasthla quissetensis.* (10 min.) (Standard lantern). **E. W. Lautenschlager** and **R. R. Cardell, Jr.,** University of Virginia, Charlottesville, Va.

12. The life history of the turtle lung fluke, *Heronimus chelydrae* MacCallum. (10 min.) (2×2 lantern). **R. B. Crandall,** Purdue University, Lafayette, Ind.

13. Studies on the life history of a species of Acanthatrium (Trematoda: Lecithodendriidae). (7 min.) (Standard lantern). **F. J. Etges,** University of Cincinnati, Cincinnati, Ohio.

14. The early development of *Pinguinicollum pinguinicollum* (Tetraphyllidea) and of *Dasyrhynchus sp.* (Trypanorhyncha). (10 min.) (Standard lantern). **L. T. Douglas,** Emory and Henry College, Emory, Va.

15. Studies on the life cycle of *Neogogatea pandionis* Chandler and Rausch 1948 (Trematoda: Strigeoidea: Cyathocotylidae). (10 min.) (2×2 lantern). **G. L. Hoffman,** U. S. Fish and Wildlife Service, Kearneysville, W. Va.

16. Avian schistosomes of the genus *Ornithobilharzia* at Lake Okoboji, Iowa. (5 min.) (Standard lantern). **M. J. Ulmer,** Iowa State College, Ames, Iowa.

17. Host-parasite relationships of *Spirorchis elegans* Stunkard (Trematoda: Spirorchiidae). (5 min.) (Standard and 2×2 lantern). **P. J. Schroeder** and **M. J. Ulmer,** Iowa State College, Ames, Iowa.

Read by Title Only

18. Four species of *Paragonimus* occurring in Japan. **I. Miyazaki,** Kyushu University, Fukuoka, Japan.

19. Studies on the route of the migration of the larvae of *Paragonimus westermani* in rats by Evans-blue technique. I. The excystation times and the distribution of the penetration sites of the excysted larvae. **M. Yokogawa, H. Yoshimura, T. Okura, M. Sano, M. Tsuji** and **S. Takano,** Chiba University, Chiba, Japan.

20. Studies on host-parasite relationship. I. Experimental infection in rats, mice and guinea pigs with the metacercariae of *Paragonimus chirae* Miyazaki, 1939. **M. Yokogawa, H. Yoshimura, M. Sano, T. Okura, M. Tsuji** and **S. Takano,** Chiba University, Chiba, Japan.

21. Trematode infections in some domesticated animals in the Sudan. **E. Abdel-Malek,** University of Khartoum, Sudan, Africa.

22. Ecological studies of *Cryptocotyle lingua* (Trematoda: Heterophyidae) whose larvae cause "pigment spots" of marine fish. **C. J. Sindermann** and **A. E. Farrin,** U. S. Bureau of Commercial Fisheries, Boothbay Harbor, Maine.

23. The life history of a species of *Philophthalmus,* an eye-fluke of birds in the Hawaiian Islands. **J. E. Alicata** and **K. Noda,** University of Hawaii, Honolulu, Hawaii.

24. The dog face baboon, *Papio doguera,* a primate reservoir host of *Schistosoma mansoni* in East Africa. **J. H. Miller,** Louisiana State University, New Orleans, La.

25. A proposed reclassification of the gastrocotyloid Monogenea. **E. W. Price,** Jacksonville State College, Jacksonville, Ala.

26. The fish, *Cyprinodon,* as the intermediate host for a new species of the trematode genus *Ascocotyle.* **W. L. Leigh,** University of Miami, Coral Gables, Florida.

27. Observations on larval development of the heterophyid, *Stellantchasmus falcatus,* in snails. **K. Noda,** University of Hawaii, Honolulu, Hawaii.

28. The production of F_2 offspring from F_1 (hybrids) of *Oncomelania nosophora* and *O. hupensis.* **Y. Komiya** and **K. Kojima,** National Institute of Health, Tokyo.

Monday Morning Session B, August 31, 9:00 A.M.

Room 219, Electrical Engineering Building

Dale A. Porter, Agricultural Research Service, PRESIDING

Read

29. Observations on the life history of *Ornithodoros kelleyi* Cooley and Kohls, 1941 (Acarina: Argasidae). (10 min.) (Standard lantern). **D. E. Sonenshine,** University of Maryland, College Park, Md.

30. The biology of *Culex tarsalis* Coq. raised in the dark at 18°C. (8 min.) (Standard lantern). **J. Chao,** University of California at Los Angeles, Los Angeles, Calif.

31. Microorganisms isolated from the digestive tract of *Culex tarsalis* Coq. (7 min.) (Standard lantern). **J. Chao** and **G. Wistreich,** University of California at Los Angeles, Los Angeles, Calif.

32. Transovarial passage of radioactivity in ticks labeled with C^{14} glycine. (8 min.) (Standard lantern). **K. E. Hyland, Jr.** and **J. L. Hammar,** University of Rhode Island, Kingston, R. I.

33. A three year survey of the infection rate of *Echinorhynchus coregoni* and *Cyathocephalus truncatus* in the intermediate host *Pontoporeia affinis* from South Bay Mouth, Ontario. (12 min.) (2×2 lantern). **D. L. DeGiusti** and **J. Bud,** Wayne State University, Detroit, Mich., and Ontario Fish Research Laboratory, South Bay Mouth, Ontario.

34. Fish hosts of the Caryophyllidea (Cestoda). (7 min.) (2×2 lantern). **J. S. Mackiewicz,** Cornell University, Ithaca, N. Y.

35. Development of epidermal glands and enclosing membranes of a dilepidid oncosphere. (8 min.) (2×2 lantern). **R. E. Ogren,** Dickinson College, Carlisle, Pa.

36. Experimental autoreinfection of *Hymenolepis nana* in isolated mice restrained from coprophagy. (10 min.) (Standard lantern). **D. Heyneman,** University of California, Los Angeles, Calif.

37. A population of branched tapeworms (*Hymenolepis nana*) found in a strain of DBA-1 mice. (5 min.) (Standard lantern). **D. Heyneman,** University of California, Los Angeles, Calif.

38. Minimum development compatible with infectivity in the larval stages of *Spirometra mansonoides.* (8 min.) (Standard lantern). **J. F. Mueller,** State University of New York, Upstate Medical Center, Syracuse, N. Y.

39. Substitution of a cell-free culture system for the second intermediate host in the life cycle of *Spirometra mansonoides.* (7 min.) (Standard lantern). **J. F. Mueller,** State University of New York, Upstate Medical Center, Syracuse, N. Y.

40. Temperature stress and development of *Hymenolepis diminuta* in *Tribolium confusum* on different diets. (10 min.) (Standard lantern). **M. Voge,** University of California, Los Angeles, Calif.

41. Kinetics of amino acid penetration in tapeworms. (10 min.) (Standard lantern). **C. P. Read, J. E. Simmons,** and **A. H. Rothman,** Johns Hopkins University, Baltimore, Md.

42. The uptake of glucose by *Hymenolepis diminuta.* (10 min.) (Standard lantern). **K. Phifer,** Johns Hopkins University, Baltimore, Md.

43. The physiology of tapeworms, correlated to structures seen with the electron microscope. (10 min.) (Standard lantern). **A. H. Rothman,** Johns Hopkins University, Baltimore, Md.

44. A procedure for comparative studies of mutagenesis in cestodes. (8 min.) (Standard lantern). **E. L. Schiller,** Johns Hopkins University, Baltimore, Md.

45. Preliminary experiments on the growth of a Cyclophyllidean cestode in vitro. (8 min.) (Standard lantern). **E. L. Schiller, C. P. Read** and **A. H. Rothman,** Johns Hopkins University, Baltimore, Md.

46. Studies on the cestode genus *Marsipometra* Cooper (Pseudophyllidea: Amphicotylidae). (10 min.) (Standard and 2×2 lantern). **F. P. Meyer** and **M. J. Ulmer,** Iowa State College, Ames, Iowa.

47. Studies on the serology of echinococcosis. (10 min.) (Standard lantern). **I. G. Kagan, L. Norman** and **D. S. Allain,** Communicable Disease Center, Public Health Service, Atlanta, Ga.

48. The life histories of the two species of echinococcus of man. (16 min. sound movie) (Motion picture projector, 16 mm., for sound). **T. B. McGath** and **J. H. Thompson, Jr.,** Mayo Clinic and Mayo Foundation, Rochester, Minn.

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49. Physiologic studies on the larval and adult scolex of *Spirometra mansonoides.* **J. F. Mueller,** State University of New York, Upstate Medical Center, Syracuse, N. Y.

50. Interaction between dietary carbohydrate quality and quantity in the nutrition of *Hymenolepis diminuta.* **J. C. Holmes,** Rice Institute, Houston, Texas.

51. Competition for carbohydrate between the rat tapeworm, *Hymenolepis diminuta,* and the acanthocephalan, *Moniliformis dubius.* **J. C. Holmes,** Rice Institute, Houston, Texas.

Monday Afternoon Session, August 31, 2:00 P.M.

Room 110, Electrical Engineering Building

Paul C. Beaver, Tulane University, PRESIDING

Read

52. Parasites of commercial shrimp. (10 min.) (Standard lantern). **D. N. Kruse,** Florida State University, Tallahassee, Florida.

53. Occurrence of *Cephenemyia jellisoni* in a sample of Montana mule deer. (8 min.) (2×2 lantern). **K. J. Capelle** and **C. M. Senger,** U. S. Fish and Wildlife Service, Sacramento, and Montana State University, Missoula, Mont.

54. Louse-flies from mule and white-tailed deer in Western Montana. (7 min.) (2×2 lantern). **C. M. Senger** and **K. J. Capelle,** Montana State University, Missoula, Mont., and U. S. Fish and Wildlife Service, Sacramento, Calif.

55. On the life history of three species of hippoboscids occurring on birds in Ontario. (10 min.) (2×2 lantern). **G. F. Bennett,** Ontario Research Foundation, Toronto, Ontario. (Introduced by A. M. Fallis).

56. Blood parasites of birds in Algonquin Park, Canada, and a discussion of their transmission. (10 min.) (2×2 lantern). **G. F. Bennett** and **A. M. Fallis,** Ontario Research Foundation, Toronto, Ontario.

57. Preliminary report on the haemoparasites of rodents of Lake Bonneville Basin, Utah. (10 min.) (2×2 lantern). **J. C. Frandsen** and **A. W. Grundmann,** University of Utah, Salt Lake City, Utah.

58. Epizootics of fish lice, *Argulus biramosus,* in two lakes of Eastern South Dakota. (8 min.) (2×2 lantern). **M. O. Allum** and **E. J. Hugghins,** South Dakota State College, Brookings, S. D.

59. Lernaeids and lernaeopodids (Arthropoda: Eucopepoda) from fishes in Eastern South Dakota. (7 min.) (2×2 lantern). **E. J. Hugghins,** South Dakota State College, Brookings, S. D.

60. Zoogeopraphy of sea herring parasites. (15 min.) (2×2 lantern). **C. J. Sindermann,** U. S. Bureau of Commercial Fisheries, Boothbay Harbor, Maine.

61. A study of the parasitism of the deer mouse, *Peromyscus maniculatus,* in the Bonneville Basin of Utah and its role in parasite distribution. (5 min.) (2×2 lantern). **A. W. Grundmann** and **J. C. Frandsen,** University of Utah, Salt Lake City, Utah.

62. Digenetic trematodes of marine fishes from the Caribbean Sea adjacent to Puerto Rico and Mona Island. (10 min.) (2×2 lantern.) **A. H. Siddiqi** and **R. M. Cable,** Purdue University, West Lafayette, Indiana.

63. Observations on the development of ascaridoid nematodes of the carpet snake. (10 min.) (Standard lantern). **J. F. A. Sprent,** University of Queensland Veterinary School, Brisbane, Queensland, Australia.

64. Insects as possible paratenic hosts of *Ancylostoma caninum.* (10 min.) (Standard lantern). **M. D. Little,** Tulane University, New Orleans, La.

65. Observations on the nature of the cyst of *Trichinella spiralis.* (10 min.)

(Standard lantern). **A. L. Ritterson,** University of Rochester, Rochester, N. Y.

66. An investigation of the metabolism of the nematode, *Syngamus trachea* (Montagu, 1811) Chapin, 1925. (10 min.) (2×2 lantern). **R. F. Krueger,** Grove Laboratories, Inc., St. Louis, Mo.

67. The infectivity of *Strongyloides ratti* for various rodent hosts. (10 min.) (Standard lantern). **G. Wertheim,** Hebrew University-Hadassah Medical School, Jerusalem, and Johns Hopkins University, Baltimore, Md. (Introduced by C. P. Read).

68. The effect of cortisone on natural resistance and acquired responses of the white rat to infection with *Litomosoides carinii.* (10 min.) (Standard lantern). **N. T. Briggs,** University of Texas Medical Branch, Galveston, Texas.

69. Immunity produced by two strains of *Litomosoides carinii* in gerbils and cotton rats. (10 min.) (Standard lantern). **J. A. Scott** and **J. H. Cross, Jr.,** University of Texas Medical Branch, Galveston, Texas.

70. Free amino acid content of the blood of natural and experimental hosts of the filarial worm *Litomosoides carinii.* (10 min.) (Standard lantern). **E. A. Zein-Eldin** and **J. A. Scott,** University of Texas Medical Branch, Galveston, Texas.

71. Vital staining and differentiation of microfilariae. (15 min.) (2×2 lantern). **N. Rothstein, M. L. Brown** and **R. W. Carithers,** Walter Reed Army Institute of Research, Washington, D. C.

Read by Title Only

72. Studies on the pseudocoelmic fluid of the nematode, *Syngamus trachea* (Montagu, 1811) Chapin, 1925. **R. F. Krueger,** Grove Laboratories Inc., St. Louis, Mo.

73. Helminth-parasites of the camel, *Camelus dromedarius,* in the Sudan. **E. Abdel-Malek,** University of Khartoum, Khartoum, Sudan, Africa.

74. Spirocercosis in Khartoum dogs. **E. Abdel-Malek,** University of Khartoum, Sudan, Africa.

75. Another unusual case of erratic hirudiniasis. **M. C. Meyer,** University of Maine, Orono, Maine.

76. The occurence of *Eimeria tamiasciuri* in New Hampshire. **W. L. Bullock,** University of New Hampshire, Durham, New Hampshire.

77. A study of the parasites of the yellow fin tuna, *Thunnus catalinea,* collected from the Gulf of Mexico in the Sacramento Shoals area. **J. W. Ward,** University of Mississippi Medical Center and Gulf Coast Research Laboratory, Jackson, Miss.

78. The occurrence of *Diphyllobothrium stemmacephalum* Cobbald, 1958, from the dolphin, *Tursiops truncatus,* of the Biloxi, Mississippi, Bay. **J. W. Ward** and **R. A. Collins,** University of Mississippi Medical Center and Gulf Coast Research Laboratory, Jackson, Miss.

Tuesday Morning Session, September 1, 9:00 A.M.

Room 110, Electrical Engineering Building

Francis J. Kruidenier, University of Illinois, PRESIDING

Read

79. The effect of experimental infections of the coccidium *Eimeria faurei* on

wool. (10 min.) (Standard lantern). **J. C. Lotze,** ADP Research Division, Beltsville, Md.

80. A bacterial disease of *Ascaris suum.* (10 min.) (Standard lantern). **T. B. Stewart** and **H. J. Godwin,** USDA, ARS, Animal Disease & Parasite Research Division, Georgia Coastal Plain Experiment Station, Tifton, Ga.

81. Survival of *Histomonas meleagridis* and eggs of five species of turkey nematodes outdoors on soil. (10 min.) (Standard and 2×2 lantern). **M. M. Farr,** Animal Disease and Parasite Research Division, USDA, Beltsville, Md.

82. The incidence of swine lungworm in Nebraska. (10 min.) (2×2 lantern). **G. W. Kelley** and **H. G. Sen,** University of Nebraska, Lincoln, Neb.

83. Possible significance of the retention of immature larvae of *Oesophagostomum quadrispinulatum* (*O. longicaudum*) in the intestinal mucosa of swine after single infections. (15 min.) (Standard and 2×2 lantern). **D. A. Shorb** and **W. T. Shalkop,** Animal Disease and Parasite Research Division, USDA, Beltsville, Maryland.

84. Blood and plasma volume, total serum protein, and electrophoretic serum fractionation of sheep experimentally infected with *Trichostrongylus axei.* (10 min.) (Standard lantern). **S. E. Leland, Jr., J. H. Drudge and Z. N. Wyant,** Kentucky Agricultural Experiment Station, Lexington, Ky.

85. Studies on the serological and immunological responses of calves artificially infected with the stomach hairworm, *Trichostrongylus axei.* (10 min.) (Standard and 2×2 lantern). **H. Herlich** and **R. S. Merkal,** USDA Regional Animal Disease Research Laboratory, Auburn, Ala.

86. Experimental studies on the relationship of *Ostertagia circumcincta* to parasitic gastritis in sheep and goats. (10 min.) (Standard lantern). **K. C. Kates, G. I. Wilson** and **J. H. Turner,** Animal Disease and Parasite Research Division, ARS, USDA, Beltsville, Md.

87. Further observations on the life history and development of *Ascaridia columbae* (Gmelin, 1790) Travassos, 1913, in the pigeon. (15 min.) (Standard lantern). **E. E. Wehr** and **J. C. Hwang,** Animal Disease and Parasite Research Division, ARS, Beltsville, Md.

88. Factors influencing the distribution of *Heterakis* in the ceca of chickens and turkeys. (10 min.) (Standard lantern). **E. E. Lund,** USDA, ARS, ADPRD, Beltsville, Md.

89. The chronology of experimental intrauterine infections with *Toxocara canis* (Werner, 1782) in the dog. (10 min.) (2×2 lantern). **J. R. Douglas** and **N. F. Baker,** University of California, Davis, Calif.

90. Immunity to *Cooperia punctata* and *Oesophagostomum radiatum* in cattle. (15 min.) (2×2 lantern). **R. L. Mayhew,** Louisiana State University, Baton Rouge, La.

91. A comparison of nematode egg counting technics for cattle and sheep feces. (10 min.) (Standard lantern). **N. D. Levine, K. N. Mehra, D. T. Clark** and **I. J. Aves,** University of Illinois, Urbana, Ill.

92. Studies on parasitism of feral swine in Georgia. (15 min.) (2×2 lantern). **B. B. Babero and L. H. Karstad,** Fort Valley State College, Fort Valley, Ga. and University of Wisconsin, Madison, Wis.

93. Report on *Raillietina williamsi* in the domestic turkey. (12 min.) (2×2 lantern). **W. M. Reid** and **D. Nugara,** University of Georgia, Athens, Ga.

94. Spicular anomalies in *Haemonchus contortus* that may be associated with exposure to phenothiazine. (10 min.) (Standard lantern). **W. W. Becklund,** ARS, USDA, Beltsville, Md.

95. The nematode *Coscomercoides dukae* as a parasite of the slug. (7 min.) (2×2 lantern). **R. E. Ogren,** Dickinson College, Carlisle, Pa.

Read by Title Only

96. Microelectrophoretic studies of the serum proteins in chickens infected with cecal coccidiosis. **E. A. Schlueter,** Michigan State University, East Lansing, Mich.

97. Parasitologic surveys in Cali, Departamento del Valle, Colombia. VI. Diagnostic findings from parasitologic examination of excreta of dogs, human beings and a hog collected on the streets of Ward Siloé, Cali, Colombia. **L. E. Giraldo, E. C. Faust, R. Bonfante** and **G. Caicedo,** Universidad del Valle, Cali, Colombia.

98. Massive infestation of gastrointestinal worm parasites in a farm-raised pig. **L. A. Spindler,** USDA, ARS, ADPRD, Beltsville, Md.

99. Results of a few experiments using phenothiazine, copper sulphate and nicotine sulphate as anthelmintics in cattle. **R. L. Mayhew** and **B. B. Lank,** Louisiana State University, Baton Rouge, La.

100. Cross-transmission of *Haemonchus* from pronghorn antelope to domestic sheep with observations on the pathogenicity of this strain in lambs as compared with that of *Haemonchus* from domestic sheep. **R. W. Allen, K. S. Samson** and **G. A. Schad,** USDA, ARS, ADPRD, State College, New Mexico.

101. Occurrence of *Capillaria obsignata* Madsen, 1945, in the peafowl and its transmission to chickens. **J. C. Hwang** and **E. E. Wehr,** ARS, USDA, ADPRD, Beltsville, Md.

102. Value of piperazine dihydrochloride in the treatment of cooperiasis in calves. **J. E. Alicata,** University of Hawaii, Honolulu, Hawaii.

Tuesday Afternoon Session, September 1, 2:00 P.M.

Room 110, Electrical Engineering Building

Donald V. Moore, Southwestern Medical School, PRESIDING

Read

103. Modification of the course of infection of *Plasmodium lophurae* by the injection of components of the erythrocyte. (15 min.) (Standard lantern). **R. B. McGhee,** University of Georgia, Athens, Ga.

104. Distribution of sexual and asexual stages of *Plasmodium relictum* in the pigeon, *Columba livia.* (10 min.) (Standard and 2×2 lantern). **J. N. Farmer,** Iowa State College, Ames, Iowa.

105. Transaminases in four species of hemoflagellates. (10 min.) (Standard lantern). **R. Zeledon,** Johns Hopkins University, Baltimore, Md.

106. Reduction of trypanosome growth-factor in rat serum by host starvation. (10 min.) (Standard lantern). **D. R. Linicome** and **J. A. Hinant,** Naval Medical Research Institute, Bethesda, Md. and Howard University.

107. Further observations on the effects of chlorophyllin and hematoporphyrin in experimental *Trypanosoma cogolense* infections. (15 min.) (Standard lantern).

F. C. Goble and **J. L. Boyd,** Ciba Pharmaceutical Products, Inc., Summit, N. J.

108. The effect of pyridoxine deficiency on mice infected with the Khartoum strain of Leishmania donovani. (10 min.) (2×2 lantern). **P. Actor** and **L. A. Stauber,** Rutgers, the State University of New Jersey, New Brunswick, N. J.

109. Resistance of the mouse to superinfection with the Khartoum strain of *Leishmania donovani.* (10 min.) (2×2 lantern). **E. F. Cappuccino,** Rutgers, the State University of New Jersey, New Brunswick, N. J.

110. The serum proteins of animals infected with *Leishmania donovani.* (10 min.) (Standard lantern). **R. N. Rossan** and **L. A. Stauber,** Rutgers, the State University of New Jersey, New Brunswick, N. J.

111. Cannulation of the colon as an aid to the study of canine amebiasis. (10 min.) (Standard and 2×2 lantern). **J. Pushkin, L. H. Saxe** and **D. R. Fowler,** West Virginia Medical Center, Morgantown, W. Va.

112. Further observations on pathogenicity of *Trichomonas gallinae* and *T. vaginalis* to mice. (10 min.) (Standard lantern). **B. M. Honigberg,** Johns Hopkins University, Baltimore, Md. and University of Massachusetts, Amherst, Mass.

113. Observations on thermal resistance of *Trichomonas gallinae* and *T. vaginalis.* (5 min.) (Standard lantern). **M. H. Satti** and **B. M. Honigberg,** Johns Hopkins University, Baltimore, Md., Ministry of Health, Khartoum, Sudan, Africa, and University of Massachusetts, Amherst, Mass.

114. Epidemiological and serological observations on a toxoplasmosis outbreak in dogs. (10 min.) (2×2 lantern). **J. R. Lindsey,** Alabama Polytechnic Institute, Auburn, Ala.

115. The relationship of *Toxoplasma* dye test and neutralization antibodies. (10 min.) (Standard lantern). **L. Jacobs, J. S. Remington, H. Kaufman, M. L. Melton** and **M. N. Lunde,** National Institutes of Health, Bethesda, Maryland.

116. Hemagglutination and dye test antibodies in experimental toxoplasmosis produced by virulent and avirulent parasite strains. (10 min.) (Standard lantern). **M. N. Lunde,** National Institutes of Health, Bethesda, Maryland.

117. Congenital transmission of toxoplasmosis from mother animals with acute and chronic infections. (10 min.) (Standard lantern). **J. S. Remington, M. L. Melton and L. Jacobs,** National Institutes of Health, Bethesda, Maryland. (No abstract.)

118. Parasitemia in late (chronic) infection with *Toxoplasma* strains of low virulence. (10 min.) (Standard lantern). **J. S. Remington, M. L. Melton** and **L. Jacobs,** National Institutes of Health, Bethesda, Maryland. (No abstract.)

119. The course of infection of *Babesiosoma* sp. Jakowska and Nigrelli (1956) in experimentally infected amphibia. (15 min.) (Standard lantern). **S. M. Schmittner,** University of Georgia, Athens, Ga.

Read by Title Only

120. *Hepatocystis* (= *Plasmodium*) *kochi* in the dog face baboon, *Papio doguera.* **J. H. Miller,** Louisiana State University, New Orleans, La.

121. Potentiation of antimalarial activity of chloroquine diphosphate against *P. berghei.* **L. E. Gaudette** and **G. R. Coatney,** National Institutes of Health, Bethesda, Maryland.

122. The mode of action of antimalarial drugs. **K. A. Schellenberg** and **G. R. Coatney,** National Institutes of Health, Bethesda, Maryland.

Wednesday Morning Session, September 2, 9:00 A.M.

Room 110, Electrical Engineering Building

Robert M. Stabler, Colorado College, PRESIDING

Read

123. The effect of terephthalic acid and source of calcium on the anticoccidial activity of chlortetracycline. (10 min.) (2×2 lantern). **E. J. Burden** and **E. Waletzky,** American Cyanamid Co., Pearl River, N. Y.

124. Prophylactic activity of 1-maleinyl-4-(3′-chloro-4′-methylphenyl)-piperazine (Hoechst S 688) in experimental schistosome infections. (10 min.) (Standard lantern). **G. W. Luttermoser, J. I. Bruce and D. B. McMullen,** National Institutes of Health and Walter Reed Army Institute, Washington, D. C.

125. The curative activity of 1-maleinyl-4-(3′-chloro-4′-methylphenyl)-piperazine (Hoechst S 688) in experimental schistosome infections. (10 min.) (4×3¼ lantern). **J. I. Bruce, G. W. Luttermoser** and **D. B. McMullen,** Walter Reed Army Institute and National Institutes of Health, Washington, D. C.

126. The effects of reference anthelmintics against *Nematospiroides dubius* and oxyurids in mice relative to screening procedures for new drugs. (10 min.) (Standard lantern). **H. G. Sheffield, J. E. Meisenhelder** and **P. E. Thompson,** Parke, Davis & Company, Detroit, Michigan.

127. The comparative anthelmintic activity of four bephenium salts. (10 min.) (2×2 lantern). **M. D. Young, G. M. Jeffery, J. E. Freed, W. G. Morehouse** and **R. S. Johnson,** National Institutes of Health, Bethesda, Md. and South Carolina State Hospital, Columbia, S. C. (No abstract.)

128. Anthelmintic activity of a new organic phosphate in cattle and sheep. (10 min.) (2×2 lantern). **J. F. Landram** and **R. J. Shaver,** Dow Chemical Company, Midland, Michigan.

129. Anthelmintic activity in cattle and sheep of three new phosphoramidothicates. (10 min.) (2×2 lantern). **J. F. Landram,** Dow Chemical Company, Midland, Michigan.

130. Critical tests on the organic phosphate insecticide, Dimethoate®, against *Gastrophilus spp.* in the horse. (10 min.) (Standard lantern). **J. H. Drudge, S. E. Leland, Jr., Z. N. Wyant** and **G. W. Elam,** University of Kentucky, Lexington, Ky.

131. The effects of Caricide, diethylcarbamazine, on experimental infections of *Haemonchus contortus* and *Trichostrongylus* spp in lambs. (10 min.) (Standard and 2×2 lantern). **I. B. Wood, J. E. Emro, J. A. Pankavich, W. S. Wallace** and **E. Waletzky,** American Cyanamid Company, Pearl River, N. Y.

132. The efficacy of cyanacethydrazide in calves experimentally infected with *Dictyocaulus viviparus.* (10 min.) (2×2 lantern). **R. Rubin,** Colorado State University, Ft. Collins, Colorado.

133. The efficacy of piperazine citrate and phenothiazine against *Heterakis gallinae* and *Ascaridia galli* in chickens. (10 min.) (Standard lantern). **M. L. Colglazier, F. D. Enzie, A. O. Foster** and **D. E. Thompson,** ARS, USDA, Beltsville, Maryland.

134. Toward effective use of laboratory cultures of *Pratylenchus.* (10 min.) (Standard lantern). **J. D. Tiner,** Rutgers, the State University of New Jersey, New Brunswick, N. J.

PRESIDENTIAL ADDRESS, AMERICAN SOCIETY OF PARASITOLOGISTS
11:20 A.M.

Robert M. Stabler, Vice-President ASP, PRESIDING

135. Parasitological speculations and patterns. **A. O. Foster,** Beltsville Parasitological Laboratory, ADP, ARS, USDA, Beltsville, Maryland. (Introduced by Gilbert F. Otto, Abbott Laboratories, North Chicago, Ill.)

Wednesday Noon, September 2, 12:15 P.M.

Hetzel Union Building Ballroom
Annual Luncheon and Business Meeting of the Society

Presentation of Henry B. Ward Medal
Aurel O. Foster, PRESIDING

(Get tickets at time of registration)

Wednesday Afternoon Session, September 2, 2:30 P.M.

Room 318, Demonstrations; Room 214, Tea (4:00 P.M.); Frear Laboratories
Tien-Hsi Cheng, In Charge

(Laboratories will be open all Wednesday morning for setting up demonstrations.)

All Papers by Demonstration and Exhibit

136. Differentiation of trichomoniasis and pox infection. **L. N. Locke, C. M. Herman** and **E. S. King, Jr.,** Patuxent Research Refuge, Laurel, Maryland.

137. Parasites of the raccoon, *Procyon lotor*. **G. M. Clark** and **C. M. Herman,** Patuxent Research Refuge, Laurel, Maryland.

138. Vital staining and differentiation of microfilariae. **N. Rothstein, M. L. Brown** and **R. W. Carithers,** Walter Reed Army Institute, Washington, D. C. (See Abstract #71).

139. Host-parasite relationships of *Spirorchis elegans* Stunkard (Trematoda: Spirorchiidae). **P. J. Schroeder** and **M. J. Ulmer,** Iowa State College, Ames, Iowa. (See Abstract #17).

140. Spicular anomalies on *Haemonchus contortus* that may be associated with exposure to phenothiazine. **W. W. Becklund,** ARS, USDA, Beltsville, Maryland. (See Abstract #94).

141. Studies on avian filarial worms of the subfamily splendidofilariinae (Nematoda: Dipetalonematidae). **J. A. Cadetoyinbo** and **M. J. Ulmer,** Iowa State College, Ames, Iowa.

142. Free amino acid content of the blood of natural and experimental hosts of the filarial worm *Litomosoides carinii*. **E. A. Zein-Eldin** and **J. A. Scott,** University of Texas Medical Branch, Galveston, Texas. (See Abstract #70).

143. Nematodes from some captive animals. **B. J. Zaskoski,** Loyola University, Chicago, Ill.

144. Ultrastructure of the excretory system of cercariae. **F. J. Kruidenier,** University of Illinois, Urbana, Ill.

145. Development of epidermal glands and enclosing membranes of a dilepidid oncosphere. **R. E. Ogren,** Dickinson College, Carlisle, Pa. (See Abstract #35).

146. Four species of *Paragonimus* occurring in Japan. **I. Miyazaki,** Kyushu

University, Fukuoka, Japan. (See Abstract #18).

147. Papillae on schistosome cercariae. **A. Wagner,** Florida State University, Tallahassee, Florida.

148. Some trematodes from East Pakistan. **W. H. Coil** and **R. E. Kuntz,** University of Nebraska, Lincoln, Neb., and U. S. Naval Medical Research Unit No. 2, San Francisco, Calif.

149. The relation of climate to the epidemiology of gastrointestinal nematodes of sheep and cattle. **N. D. Levine,** University of Illinois, Urbana, Ill.

150. The life history of a species of *Philophthalmus* (Trematoda: Philophthalmidae) from the orbit of birds. **A. F. West, Jr. and F. M. Fisher,** Purdue University, West Lafayette, Ind.

151. Two new species of the genus *Xenopharynx* Nicoll, 1912 (Digenea: Plagiorchiidae). **P. N. Chatterji,** University of Illinois, Urbana, Ill.

152. Avian schistosomes of the genus *Ornithobilharzia* at Lake Okoboji, Iowa. **M. J. Ulmer,** Iowa State College, Ames, Iowa. (See Abstract #16).

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ABSTRACTS

1. **Progenetic Maturity and Phylogeny of Digenetic Trematodes.** HORACE W. STUNKARD, The U.S. Fish and Wildlife Service and the American Museum of Natural History, New York.

Sexual maturity and egg-production in metacercarial stages of digenetic trematodes have been known since the account by von Siebold (1836). Dollfus (1929) raised the question whether or not there are abbreviated life-cycles, with omission of the vertebrate host, among the Digenea. The answer was provided by Alice Buttner (1950) through repeated infection of snails with eggs taken from progenetic metacercariae that had developed in tadpoles. She listed species in some 20 genera, distributed among a dozen different families, in which progenesis had been recorded.

Stunkard and Uzmann (1959) reported that *Cercaria milfordensis* is the larva of *Proctoeces maculatus* and that the life-cycle can be completed in *Mytilus edulis*. Furthermore, I have completed the life-history of a species of *Asymphylodora* at Woods Hole, Massachusetts, through the infection of laboratory-raised *Amnicola limosa* by feeding embryonated eggs taken from worms found in naturally infected *A. limosa*. In this instance also, no second intermediate host is involved. Species of *Proctoeces* and *Asymphylodora* occur also as parasites of fishes.

Buttner suggested that progenesis may be the result of a mutation, but the occurrence of the same mutation in so many different systematic groups seems unlikely. Rather, it appears to be a relict, the survival of an earlier developmental method. The attainment of maturity in longer-lived, wider-ranging vertebrate hosts would have advantages for survival and distribution and accordingly would gradually replace a cycle in which the mollusk was the original and perhaps the only host.

2. **Chromosomes of Schistosomes.** ROBERT B. SHORT AND MARGARET Y. MENZEL, Florida State University.

Mitotic karyotypes have been analyzed, and idiograms constructed for the following species of schistosomes: *Schistosomatium douthitti* (Michigan), *Schistosoma mansoni* (Puerto Rico, Egypt, Liberia), *S. haematobium* (West Africa), *S. japonicum* (Philippines), *Ornithobilharzia canaliculata* (Florida), *Trichobilharzia physellae* (Michigan), *T. stagnicolae* (Michigan), *Austrobilharzia variglandis* (Maine) and *Gigantobilharzia huronensis* (Michigan). The chromosomes were studied in larval stages from snails.

A heteromorphic pair, interpreted as sex chromosomes (as previously reported in *S. douthitti* and *O. canaliculata* females), was not observed in the species of *Schistosoma* and *Trichobilharzia*. Since material of *Gigantobilharzia* and *Austrobilharzia* was from a single snail each, the question of heteromorphic chromosomes in these species remains unanswered.

All species studied had $2n = 16$ except *S. douthitti* ($2n = 14$). Some cercarial embryos of *T. stagnicolae* had an extra pair of small chromosomes ($2n = 18$). The karyotypes of *S. mansoni* from various localities were similar. Karyotype comparisons suggest that *S. douthitti*, a mammalian parasite, is more closely related to the bird schistosomes than to species of *Schistosoma*. (Supported by Grant E-1142 from the National Institute of Allergy and Infectious Diseases, U. S. Public Health Service.)

3. **Inhibition of Development of Cercariae of *Schistosoma mansoni* Following Ultra-Violet Irradiation.** O. D. STANDEN, Wellcome Laboratories of Tropical Medicine, London.

Freshly discharged cercariae of *S. mansoni* were exposed to ultra-violet radiation from cold cathode mercury resonance lamps emitting more than 80 percent of their energy in the region of 2537Å. Complete immobility of cercariae was produced after 4 minutes irradiation at 2.0 cm distance from source or after 5 to 10 minutes at 4.0 cm from source. At 8.0 cm distance no effect was observed after irradiation for periods up to 10 minutes. Cercariae exposed to much shorter periods of irradiation were used in experimental infection of mice and, at a given distance from source, the proportion of irradiated cercariae which developed to the adult stage in mice varied inversely with the length of time of irradiation. Complete inhibition of development was obtained after irradiation for 10 seconds at 2.5 cm distance. All irradiation was carried out through water. These experiments were performed with a lamp emitting 15 microwatts per sq cm measured at 1.0 m from source. With a more powerful lamp emitting 28 microwatts per sq cm at 1.0 m distance, cercarial development was completely inhibited after 4 to 8 seconds exposure at 5.8 cm from source.

Cercarial penetration of mouse skin was unaffected by irradiation for the minimum periods necessary to inhibit development to the adult stage. Failure in development occurred at a later phase in the life cycle.

4. **Stimulation of *Schistosomatium douthitti* Cercariae to Penetrate their Host.** ALVIN WAGNER, Florida State University.

Of 770 cercariae observed, 764 began to penetrate ear skin of adult white mice within 10 minutes after being placed on the surface. Ears stored in a moist chamber at 4° C for up to 47 days still stimulated a high percentage of cercariae; however, ears extracted with ether for several days stimulated very low percentages of cercariae to penetrate. Cercariae, when exposed to the residue remaining after evaporation of ether extracts of mouse skins, shed their tails, discharged the contents of their penetration glands and exhibited movements similar to those used during penetration. Ether extracted ears when rubbed with this residue regained part of their original capacity to stimulate cercariae to penetrate.

Cercariae were exposed to various ether soluble chemical substances which are present on or in the skin. Free fatty acids elicited reactions similar to those observed when cercariae were exposed to the residue from ether extracts of skins. Ether extracted ears when rubbed with valeric acid in a lanolin base, or when rehydrated in .06% valeric acid stimulated cercariae to penetrate. Low percentages of cercariae penetrated into a medium composed of gelatin, petroleum jelly and valeric acid.

The presence of free fatty acids in the lipid surface layer and in the keratinized layer of the epidermis, together with the experimental results given above, suggest that such acids are at least partially responsible for the stimulation of cercariae of *S. douthitti* to penetrate the definitive host.

(Supported by the National Science Foundation and by research grant E-1142 from the National Institute and Allergy and Infectious Diseases, U. S. Public Health Service.)

5. **Comparative Glandular Equipment of the Human Schistosomes.** M. A. STIREWALT, National Naval Medical Center, Bethesda, Maryland.

As a closely integrated phase of the whole procedure of cercarial penetration into and migration in host skin, a comparative histological assessment has been made of the glandular equipment of the human schistosomes. In addition, glandular secretion collected in quantity has been subjected to chromatographic analysis. At least fourteen of the simpler amino acids have been identified in the hydrolysate. The role of secretion from the pre- and post-acetabular glands will be considered against the background of factors known to influence entrance and migration of schistosome cercariae in skin.

6. **Observations on the Humoral and Cellular Basis of Resistance to *Schistosoma japonicum*,** ELVIO H. SADUN, Walter Reed Army Institute of Research, Washington 12, D. C., and SUNG SHENG LIN, 406 Medical General Laboratory, Japan.

Monkeys, rabbits, and mice developed an acquired resistance to *Schistosoma japonicum* following previous infections with the same trematode. This resistance was manifested by a significant reduction in the number and size of the developing worms. A milder degree of resistance to the development and growth of the parasites was also observed in mice injected with worm extracts, worm metabolites or serum from immune rabbits.

The cellular changes in the skin, lungs, and liver of normal and immune animals after infection with *S. japonicum* were also studied. A very marked diffuse cellular reaction was observed in initially infected animals. Conversely, in those animals which were infected at least two months previously, an intense cellular reaction occurred a few hours after penetration of the cercariae and the migration of the schistosomula was considerably retarded. Some schistosomes were trapped in the skin, others were able to reach the lungs, where many appeared to be blocked and surrounded by diffused nodules. Among those which succeeded in escaping, some were seen in the liver where they appeared stunted and sexually underdeveloped. Several worms were observed dead and infiltrated with parasites.

On the basis of these observations, it appears as if both cellular and humoral responses play an important role in the defense mechanism of immune animals to *S. japonicum* infection.

7. **The Behavior of Different Geographic Strains of *Schistosoma japonicum* in Circumoval Test.** S. Y. LI HSÜ AND H. F. HSÜ, College of Medicine, State University of Iowa.

Four geographic strains of *Schistosoma japonicum* were used: the Chinese, Formosan, Japanese, and Philippine. Serums were obtained from the rabbits infected with *S. japonicum*, and eggs of this parasite from the infected mice. Circumoval precipitates were observed stronger between the eggs and serum of the same strain than between those of the different strains.

8. **Studies on Schistosomiasis. XIV. Effects of Cortisone Upon the *Schistosoma mansoni* Burden in Mice.** C. J. WEINMAN AND GEORGE W. HUNTER, III, Department of Micro-

biology, College of Medicine, University of Florida.

It is known that the adrenocortical hormones have a marked influence on the course of a number of infectious diseases. Coker (1957, Proc. Exptl. Biol. and Med. **96:** 13) found that cortisone apparently enhanced the natural resistance of mice to *Schistosoma mansoni.* In order to verify these findings and to ascertain the effect of cortisone on the various natural barriers through which the schistosomulae of *S. mansoni* must pass, the following experiments were run.

Cortisone acetate Merck was administered to male mice (CFW strain) in doses of 0.5 mgm at different times in relation to an initial infection with *S. mansoni.* One group received cortisone for four days prior to infection, another was treated for seven days beginning 24 hours after infection, a third group received seven daily injections of hormone beginning five days after infection, and a fourth group was treated on days – 1, 0, 1, 3, 4, 5, 7. Controls were injected with physiological saline. The criterion of hormone influence upon infection was the number of parasites recovered from the portal system and liver approximately six weeks after exposure to an average of 50 cercariae of *S. mansoni* compared with the number in the saline injected controls. All of the cortisone-treated groups showed a small but statistically significant reduction in worm burden regardless of when the cortisone was administered.

(This investigation was supported in part by a grant (E-1893) from the National Institutes of Allergy and Infectious Diseases, Public Health Service.)

9. **The Influence of Very Low Concentrations of Sodium Pentachlorophenate upon the Fecundity and Egg Viability of** *Australorbis glabratus.* Louis Olivier and W. T. Haskins, U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Bethesda, Maryland.

The purpose of the study was to learn whether very low concentrations of the chemical (NaPCP) might show promise for snail control in the field.

The concentrations used were 0.05 and 0.1 ppm. In each of 4 experiments the fecundity of large groups of snails was determined by recording the average number of eggs produced per snail per day for 7 or 8 days. The snails were then exposed to the chemical for 7 or 8 days after which time they were returned to untreated water and observed for 7 or 8 more days. Suitable controls were observed for the same period. Two laboratory strains of the snail were used.

The higher concentration of NaPCP (0.1 ppm) killed relatively few of the adult snails in 7 to 8 days (23 and 26 percent versus 2 and 10 per cent among the controls). Nevertheless, it very rapidly reduced egg production of the snails of both strains from either 12.0 or 14.6 eggs per snail per day to 1.8 eggs or less per snail per day. Egg production of the controls either rose or remained essentially unchanged. Most of the eggs produced by the snails in the presence of the NaPCP were found dead on examination within one day of laying. At the end of the treatment period, egg viability returned approximately to the normal level within one day and egg production increased gradually.

The lower concentration of NaPCP (0.05 ppm) was not lethal for the adult snails (5 and 9 percent versus 3 and 15 percent among the controls). With one of the snail strains the effect on egg production was essentially the same as that of the higher concentration. Egg production dropped to about half of the expected level and egg viability was very low. With the other snail strain, although egg viability was greatly reduced, egg production was not affected.

10. **Electrophoretic Studies of the Sera of White Rats and Cats Following Infection with** *Paragonimus kellicotti* **Ward, 1908.** F. J. Kruidenier and A. K. Katoh, University of Illinois, Urbana.

A series of white rats was selected at random from a group of females of the same age and fed 50 metacercariae of *Paragonimus kellicotti* apiece. The remainder of the group was maintained as normal controls for the experiment. All animals were kept in the same bank of cages under the same conditions. Blood was drawn from individual animals by cardiac puncture at roughly periodic intervals. The animals were then sacrificed in order to determine the extent of the infection. Uninfected controls were tested with each group of infected animals. Blood from several animals was pooled on one occasion only. The sera were fractionated by paper electrophoresis using borate, phosphate and veronal buffer solutions in a horizontal bridge (LKB) apparatus. The several components were identified by comparison with the variously reported fractions of normal and diseased animals. A smaller series of cats was similarly infected and studied. A distinct increase in the beta-gamma serum fractions accompanied infections in both host species. This appears to be due primarily to an increase in gamma globulin component. Little or no change appears to occur in the actual albumin and alpha globulin fractions although relative decreases are apparent.

11. **Ultrastructure of the Surface Layers of a Strigeid Metacercaria,** *Diplostomulum trituri,* **and an Echinostome Cercaria,** *Himasthla quissetensis.* E. W. LAUTENSCHLAGER AND R. R. CARDELL, JR., University of Virginia.

Specimens of *Diplostomulum trituri* were recovered by dissection from the brain and brain case of the newt, *Triturus viridescens.* Specimens of *Himasthla quissetensis* were obtained upon emergence from the snail, *Nassa obseleta.* Materials to be studied were freshly fixed in buffered 1 percent osmium tetroxide, sectioned transversely at approximately 250 A, and examined with the use of an RCA electron microscope.

Light microscope examination of *D. trituri* shows a stratification of the surface layers, with an outermost homogenous layer 4 microns in thickness and an inner layer 2 microns in thickness. The electron microscope reveals that the apparently homogenous outer layer actually contains distinguishable micro-structures. Distinct micro-structures include numerous "micro-canals," 0.2–0.4 micron in diameter, and irregular, rod-like, osmophilic elements, 0.2–0.3 micron by 0.03 micron.

As examined with the light microscope, the surface structure of *H. quissetensis* also reveals an outer layer of homogenous texture. This layer is 2.3 microns in thickness. There is a basal portion approximately 0.5 micron in thickness. The outermost layer contains "micro-canals" which are approximately 0.1 micron in diameter, and oblong, osmophilic elements, 0.5 micron by 0.1 micron. The basal layer appears as a repeating pattern of osmophilic bodies with a periodicity of approximately 0.3 micron.

12. **The Life History of the Turtle Lung Fluke,** *Heronimus chelydrae* MacCallum. R. B. CRANDALL, Purdue University.

Adults of *Heronimus chelydrae* evidently do not lay eggs in the lungs of the turtle but instead migrate up the trachea to the outside and imbibe water whereupon the miracidia hatch *in utero* and escape through the genital pore. They penetrate *Physa* sp., migrate to the mantle region and develop into sporocysts with paired lateral branches. Embryos within the miracidium-sporocyst give rise directly to amphistomate cercariae with cuticular spines and a well developed tail containing flame cells near its base. Cercariae escape from the miracidium-sporocyst but normally do not emerge from the snail although they are good swimmers when freed mechanically. The turtle becomes infected by eating snails containing the active, unencysted cercariae which may be released in the mouth if the snail is crushed; if not, they are freed in the stomach and migrate up the esophagus. From the mouth, the larvae reach the lungs by way of the glottis and trachea. At summer temperatures in north-central Indiana, the worms require about 90 days to produce eggs containing fully developed miracidia but under natural conditions the infection probably is acquired during one summer and matures the next. Meanwhile, the cuticular spines are lost, the posterior sucker degenerates completely, and the excretory pore gradually shifts toward the anterior end on the dorsal side of the worm as a result of differential growth.

13. **Studies on the Life History of a Species of** *Acanthatrium* **(Trematoda: Lecithodendriidae).** FRANK J. ETGES, University of Cincinnati.

The stages and hosts of an apparently new species of Acanthatrium have been studied experimentally. Materials were collected in the vicinity of the University of Virginia Biological Station, Mountain Lake, Virginia.

Minute. virgulate xiphidiocercariae are produced in small, ovoid sporocysts developing in the liver and gonad tissues of the snail, *Anaplocamus dilatatus.* Cercariae are shed by this snail continuously and in large numbers daily. A mayfly nymph, Hexagenia, is penetrated through abdominal gills by the cercariae. Cercarial bodies grow and develop in the abdominal and thoracic muscles, but do not encyst. Encystment occurs at the time of the subimaginal molt, regardless of the age of the cercariae. The possible mechanisms controlling metacercarial encystment are not known, but seem associated with molting of the host. Juvenile adult worms were found in the small intestine of laboratory mice, five to twelve days following ingestion of experimentally infected mayflies. No infections were found following ingestion of infected mayfly nymphs. It appears that encystment is necessary for these worms to become infective to mice.

Attempts to find natural infections of Acanthatrium identifiable as the same species which was experimentally obtained failed. All specimens collected from bats were much larger and matured, due probably to greater age and host differences.

(This work was done with the aid of a National Science Foundation Grant, made through the University of Virginia.)

14. **The Early Development of** *Pinguinicollum pinguinicollum* **(Tetraphyllidae) and of** *Dasyrhynchus sp.* (Trypanorhyncha). L. T. DOUGLAS, Emory and Henry College.

In *P. pinguinicollum* fertilization, cleavage, and later embryo development resemble that of cyclophyllidean cestodes. A conspicuous fertilization cone is formed, cleavage is alternate, and regular to the five or six-cell stage, three sizes of blastomeres are formed early, and yolk cells do not enclose the developing embryo.

In *Dasyrhynchus sp.* (from *Raja kincaidii*) early embryonic development is similar to the same process in the pseudophyllidea. Early uterine oöcytes are surrounded by yolk cells together with a thick egg shell membrane and the first four blastomeres are approximately equal in size.

15. **Studies on the Life Cycle of** *Neogogatea pandionis* **Chandler and Rausch,** 1948 (Tremadoda: Strigeoidea: Cyathocotylidae). GLENN L. HOFFMAN, Eastern Fish Disease Lab, U. S. Fish and Wildlife Service, Kearneysville, West Virginia.

This parasite was described in 1948 from the osprey, *Pandion haliaëtus carolinensis*, in Wisconsin and has not been recorded since.

During the summer of 1958 the writer found cyprinid fish, particularly *Leucosomas corporalis*, near Leetown, West Virginia, heavily infected with an unknown strigeoid metacercaria. Subsequent force-feeding of newly hatched chicks with the metacercariae yielded ovigerous adults in 7–11 days. The eggs were fertile and miracidia emerged in 27 days at room temperature (21–25° C.). Attempts to infect the snails *Physa, Helisoma, Stagnicola, Fossaria,* and *Mudalia* failed.

The metacercaria appears to be very similar to European cyathocotylids; none have been fully described from North America. The most striking cyathocotylid characteristic is the "W" shape of the reserve excretory bladder.

The experimental adult differs slightly from the original description: there is a weak ventral sucker instead of lack of one, and there are small spines on the forebody. Dr. Georges Dubois kindly verified the identification.

16. **Avian Schistosomes of the Genus** *Ornithobilharzia* **at Lake Okoboji, Iowa.** MARTIN J. ULMER, Iowa State College.

Studies have been underway since 1954 on dermatitis-producing schistosome cercariae of the Lake Okoboji region in northwest Iowa. During the summer of 1958 the paucity of naturally-infected physid snails known to harbor dermatitis-producing cercariae prevented further studies on this aspect of the problem. Examination of migratory water birds was consequently begun and such studies are being continued. One of 4 ring-billed gulls (*Larus delawarensis*) examined in August, 1958, harbored 21 adult schistosomes of the genus *Ornithobilharzia*. Measurements of unflattened adults, together with measurements from serial sections of males, females and worms *in copula* indicate that the species dealt with differs markedly from previously described members of the genus. Male worms possess a well-developed gynaecophoric canal whose borders enclose the much smaller female worms. Of the known species of *Ornithobilharzia* from avian hosts, these adults are in many respects similar to *O. intermedia* Odhner, 1912. Studies on the life cycle are in progress.

(This investigation is supported in part by a grant from the National Science Foundation.)

17. **Host-parasite Relationships of** *Spirorchis elegans* **Stunkard (Trematoda: Spirorchiidae).** PATRICIA J. SCHROEDER AND MARTIN J. ULMER, Iowa State College.

Careful examination of 28 turtles (24 *Chrysemys picta belli*, 2 *Chelydra serpentina*, 1 *Pseudemys scripta elegans* and 1 *Emys blandingi*), collected in the vicinity of the Iowa Lakeside Laboratory, Lake Okoboji, Iowa, yielded 4 species of spirorchid trematodes (*S. elegans, S. artericola, S. pseudemyae* and *S. scripta*). Of these, *S. elegans* was the most frequently encountered and was always recovered from the lymphatics or connective tissues of the esophageal submucosa of the painted turtle (*C. picta-belli*). Previous investigators have recovered this fluke from intestinal washings. Its location in areas other than the blood-vascular system is further evidence for the necessity of emending the family diagnosis for Spirorchiidae.

Similarities between *S. pseudemyae* and *S. artericola* and wide variation among individuals of a single spirorchid species suggest the need for study of a large number of experimentally-reared adult worms.

(These studies are supported in part by a grant from the National Science Foundation.)

18. **Four Species of *Paragonimus* Occurring in Japan.** ICHIRO MIYAZAKI, Department of Parasitology, Faculty of Medicine, Kyushu University, Fukuoka, Japan.

The mammalian lung fluke, *Paragonimus*, is one of the most harmful parasites in our country, but concerning its taxonomy, *P. westermani* (Kerbert, 1878) had been regarded for a long time as the one and only species of the genus in Japan. In 1939 I discovered the 2nd species, *P. ohirai* Miyazaki, 1939, and then in 1943 I found the 3rd one, *P. iloktsuenensis* Chen, 1940, which was first discovered in Canton, China. Most recently in 1954 I found the 4th species of the genus, which was identified as *P. kellicotti* Ward, 1908 by making a comparison with the American specimens of the same species.

These 4 species of *Paragonimus* are divided into 2 groups by the characteristic arrangement of cuticular spines of adult worms, namely those of *westermani* and *kellicotti* are mainly arranged singly, but those of *ohirai* and *iloktsuenensis* are always arranged in group. On the other hand, *westermani* is distinguished from the other 3 by the shape of ovary of the adult: viz., the ovary of the former is divided into 6 lobes, but that of the latter is far complicated in branching. Accordingly, adult *ohirai* is easily distinguishable from *westermani* and *kellicotti*, but not so easily from *iloktsuenensis*. However, it is not impossible to differentiate it from the last one by the facts that testes are larger in *iloktsuensis* than in *ohirai* and the ratio of the testes to the ovary is larger in the former than in the latter.

In the stage of metacercariae the 3 species are more easily distinguished from one another: Those of *westermani* and *ohirai* have 2 layers in their cysts, a thin, fragile outer layer and a thick, strong inner one, but those of *iloktsuenensis* have only 1 layer, lacking the strong inner one; therefore, the metacercariae of the last species can excyst very easily. The cysts of *westermani*, excluding the outer layer, are spherical in shape and about 0.4 mm in diameter, but those of *ohirai* are almost oval in shape and much smaller than the former, measuring 0.3×0.24 mm in average. Moreover, the inner layer of *westermani* is much thicker than that of *ohirai*, measuring over 5 times as thick as the latter. The excysted larvae are the largest in *westermani*, a little smaller in *ohirai* and conspicuously small in *iloktsuenensis*. The metacercariae of *kellicotte* are yet unknown in Japan.

The second intermediate hosts of *westermani* are *Eriocheir japonicus, Potamon dehaani* and *Cambarus clarkii*, of which the first is the most significant as the vector of human paragonimiasis. Those of *ohirai* are *Sesarma intermedia, S. dehaani, S. haematocheir, Helice tridens tridens* and *Chasmagnathus convexus;* those of *iloktsuenensis* are *S. dehaani* and *H. tridens tridens*. The first intermediate host of *westermani* is *Semisulcospira libertina;* that of *ohirai* is *Assiminea japonica* and *A. parasitologica;* that of *iloktsuenensis* and *kellicotti* is not yet known in Japan. Incidentally, *A. parasitologica* was erroneously identified as *Paludinella devilis* last year.

19. **Studies on the Route of the Migration of the Larvae of *Paragonimus westermani* in Rats by Evans-blue Technique. I. The Excystation Times and the Distribution of the Penetration Sites of the Excysted Larvae.** MUENO YOKOGAWA, YOSHIMURA, H., OKURA, T., SANO, M., TSUJI, M. AND TAKANO, S., The Chiba University.

In this paper, the excystation time of the metacercariae in the intestine and the location of the penetration sites of the excysted larvae in the intestinal walls of the rats were determined by Evans-blue technique. Twenty metacercariae were fed to each of 30 rats and each 10 rats were sacrificed 30 minutes, 60 minutes and 3 hours after ingestion of the metacercariae, respectively. 3.5–4.5 cc per kg of 5 percent Evans-blue solution was injected intravenously 15 minutes before sacrifice.

The penetration sites of the intestinal walls were shown as a prominent blue spot with a haemorrhage within 15 minutes after injection of Evans-blue. These blue spots with haemorrhage were found along the walls of the small intestine and never found in the walls of stomach or caecum. The excysted larva buried in the abdominal walls was also found as a blue spot 1 hour after ingestion.

Some of the penetration sites were not stained by Evans-blue and were shown only as haemorrhagic spots 3 hours after ingestion.

The number of the blue spots of the intestinal walls coincided with the number of the larvae found in the abdominal cavity within 60 minutes after ingestion.

Three to 13 (average 6.4) of larvae were found in the abdominal cavity within 1 hour after ingestion.

Though the suitable pH of the media for the excystation of the metacercariae in vitro was thought to be 8.0–8.4, the pH of the intestinal content of the rat was 3.8 to 6.6.

20. **Studies on Host-Parasite Relationship. I. Experimental Infection in Rats, Mice and Guinea Pigs with the Metacercariae of *Paragonimus ohirai* Miyazaki, 1939.** MUNEO

YOKOGAWA, YOSHIMURA, H., SANO, M., OKUA, T., TSUJI, M. AND TAKANO, S., The Chiba University.

A known number of metacercariae of *Paragonimus ohirai* was fed to rats, mice and guinea pigs and these animals were autopsied in various periods after infection. Table 1 shows that about the half of the metacercariae given to rats was found developed in rats.

In the single worm infection no worm-cyst formation was found in the lungs and the worm which developed to sexual maturity was found free in the pleural cavity of the rat.

The cyst-formation in the lungs was always found in more than two worms infection and the most of the cysts were located in the right lungs.

The survival period of the worms seemed to be closely related to the number of the parasitic worms.

The survival period of the worms decreased according to the increase of the number of parasitic worms.

In the experimental infection of mice the percentages of metacercariae developed were almost the same as in rats. (No significant difference between them.)

But the cyst-worm formation was not found in the lungs of mice even in multiple infections except the one case.

The percentage of metacercariae found in the pleural cavity of guinea pigs was very low (3–28 percent) and no metacercaria developed to sexual maturity.

21. **Trematode Infections in Some Domesticated Animals in the Sudan.** EMILE ABDEL MALEK, University of Khartoum.

Digenetic trematodes from domesticated animals, particularly cattle and equines, were collected and, together with their known intermediate hosts, mapped. Special attention was given to schistosomiasis and fascioliasis. *Fasciola gigantica* was collected from cattle, sheep and goats, and *Schistosoma bovis* from cattle, sheep, horses, camels and pigs. In the White Nile reservoir seasonal variation in snail colonies and in their infection rates was observed during five years and recorded in detail over a year. Colonies of *Lymnaea natalensis* build up in October and November; infected snails and metacercariae of *Fasciola gigantica* are encountered in December. The peak of infection of *Lymnaea natalensis* with *Fasciola gigantica* occurs in late February and March in the reservoir as a whole, and in April in residual pools. *Bulinus truncatus* and *Bulinus* (*Physopsis*) *ugandae* were found to be naturally infected with *S. bovis*. In one locality in the White Nile reservoir no schistosome infection was found in *B.* (*Ph.*) *ugandae* at the end of September. The infection rate with *S. bovis* averaged 0.1 percent in November, December and early January, as compared to 42.1 percent for an amphistome infection (*Paramphistomum microbothrium*) in the same species of snail. In March, the infections were 0.92 percent for *S. bovis*, 65.4 percent for the amphistome, and 0.3 percent for both together.

The amphistomes *Paramphistomum microbothrium* and *Cotylophoron cotylophorum* were collected from cattle, sheep and goats, and *Gastrodiscus aegyptiacus* from equines. The identity of amphistome cercariae from *Bulinus truncatus*, *B. forskalii*, *B.* (*Ph.*) *ugandae*, and *Biomphalaria sudanica* is being determined by feeding encysted metacercariae to various hosts; sheep, goat, calf, and donkey. Cercariae from some *B. forskalii* were similar to those of *Gastrodiscus aegyptiacus*.

22. **Ecological Studies of *Cryptocotyle lingua* (Trematoda: Heterophyidae) Whose Larvae Cause "Pigment Spots" of Marine Fish.** CARL J. SINDERMANN AND ALVA E. FARRIN, U. S. Bureau of Commercial Fisheries.

It is not unusual to find many species of inshore marine fishes liberally peppered with black spots resulting from host reaction to larval trematode invasion. Sea herring, among others, are subject to invasion by cercariae of *Cryptocotyle lingua*, and may in fact be killed by massive worm exposures (Sindermann and Rosenfield, Maine Dept. Sea & Shore Fish. Res. Bull. **21**: 1–16, 1954). As part of a continuing study of the ecological role of parasites and diseases in the marine environment, a year round examination has been made of *Cryptocotyle* incidence and cercarial emergence from snail hosts (*Littorina littorea*).

Infections were most abundant in snail sample from the high-tide zone, and decreased sharply in mid- and low-tide zones. The percent of snails with infections was highest in winter, but *mature* infections, as indicated by active cercariae in crushed preparations, were most numerous from May to November. Cercarial emergence occurred only from May to December, when water temperatures exceeded 6° C. A peak of emergence was reached in late summer, coincident with maximum sea water temperature. Marking experiments indicated that some snail migration among tide zones occurred, especially from the high tide zone in early winter and to the high tide zone in early spring. This migration did not appear to be related to presence or

absence of parasitization.

The general ecological picture that has emerged is one of maturation of infections and beginning of cercarial emergence in spring when sea water temperatures rise and fish move inshore. Late autumn decline in cercarial emergence and in numbers of mature infections coincides with falling sea water temperatures and retreat of fish from inshore waters.

23. **The Life History of a Species of *Philophthalmus*, an Eye-Fluke of Birds in the Hawaiian Islands.** J. E. ALICATA AND KAORU NODA, University of Hawaii.

Local fresh water snails, *Tarebia granifera mauiensis* Lea, have been found naturally infected with a species of gymnocephalus cercaria which encysted soon after emergence from the snail. Encysted metacercariae fed to laboratory raised chicks and ducklings matured in the conjunctival sac 4 weeks following infection. The body of this cercariae measures 535 to 567 microns long by 117 to 132 microns wide and possesses a constriction at the region of the acetabulum. The tail is 409 to 456 microns long. The cyst wall enclosing the metacercaria is pear-shaped, 283 to 299 microns long by 173 to 189 microns in maximum width; it has a dome-like elevation at the narrower end and the rest of the wall is enveloped by 2 lateral wing-like membranous structures. The adult flukes resemble *P. gralli* Mathis and Leger, 1910. The fully developed eggs measure 140 to 154 microns long by 60 to 74 microns wide, and contain oculated miracidia each enclosing a redia. The eggs may be recovered by sqirting some water in the conjunctival sac and collecting the water in a small vessel. The eggs hatch rapidly in water.

Natural infection with *Philophthalmus* has been found in local water birds, *Fulica americana alai* Peale, a subspecies of the American coot. Up to the present, 17 species of *Philophthalmus* have been described from birds and twice from man. It is suspected that many are synonyms. With the elucidation of the life history will make it possible to obtain a larger number of specimens from several hosts which may prove helpful in evaluating the various species described.

(Supported in part by Research Grant E-1647 from the Division of Research Grants, National Institutes of Health, Public Health Service.)

24. **The Dog Face Baboon, *Papio doguera*, a Primate Reservoir Host of *Schistosoma mansoni* in East Africa.** JOSEPH H. MILLER, Louisiana State University School of Medicine.

One hundred and fifty baboons of various ages were captured near Kibwezi in southeastern Kenya. All animals were anesthetized, exsanguinated and autopsied. A single fecal specimen was collected from each of 143 baboons. Formalin-ether centrifugal sedimentation of the specimens disclosed small numbers of *Schistosoma mansoni* eggs in 4 of the samples.

Sections of liver and intestine removed at autopsy as well as blocks of these organs cleared in beechwood creosote were examined for the presence of *S. mansoni* eggs. Three fetuses and 13 baboons classified as infants on the basis of dentition characteristics were uninfected and were not considered in the results since exposure to infection did not seem likely in their cases. The remaining 134 baboons classified as children or older contained 74 males and 60 females. Thirty-two of these (23.9 percent) exhibited pseudotubercle formation about *S. mansoni* eggs in the liver. Nineteen (59.4 percent) of the 32 infected baboons had eggs with pseudotubercle formation in the submucosa of the descending colon and/or eggs in the mucosa with little tissue reaction.

S. mansoni adult worms and viable eggs subsequently were recovered from other baboons in Kenya (Nelson, G. S. 1958, personal communication).

The prevalence of natural infections as well as the extent of the visceral lesions indicate that *Papio doguera* is a reservoir host of *S. mansoni* in East Africa.

25. **A Proposed Reclassification of the Gastrocotyloid Monogenea.** EMMETT W. PRICE, Jacksonville State College, Jacksonville, Alabama.

A recent study of some exotic and indigenous species of Monogenea has yielded information that makes desirable a revision of the gastrocotyloid forms. This study has also revealed a number of errors of judgment by the writer and others, due largely to reliance on faulty descriptions and unavailability of material for verification of alleged characters.

In order to maintain continuity, it appears desirable to recognize a new superfamily and to redistribute certain of the genera which have been included in the family Gastrocotylidae. A new genus, *Yamaguticotyla*, for *Microcotyle truncata* Goto, is proposed.

The material presented herein is being used as a basis for an installment of the series published by the writer under the general heading "North American Monogenetic Trematodes."

Superfamily GASTROCOTYLOIDEA, n. superfam.

Family Gastrocotylidae Price, 1943
Subfamily Gastrocotylinae Sproston, 1946

Included genera: *Gastrocotyle* Beneden and Hesse, 1863; *Pseudaxine* Parona and Perugia, 1890; *Allopseudaxine* Yamaguti, 1943; *Scomberocotyle* Hargis, 1956; *Amphipolycotyle* Hargis, 1957; *Yamaguticotyla*, n. g., type *Y. truncata* (Goto, 1894) n. comb.; *Chauhanea* Ramalingham, 1953; *Winkenthughesia* Price, 1943.

Subfamily Priceinae Chauhan, 1945

Included genera: *Pricea* Chauhan, 1945; *Thoracocotyle* MacCallum, 1913; *Neothoracocotyle* Hargis, 1956; *Gotocotyla* Ishii, 1936 (syn. *Lithidocotyle* Sproston, 1946, *Pseudomicrocotyle*, Sandars, 1947).

Family Protomicrocotylidae Poche, 1925
Subfamily Protomicrocotylinae Johnston and Tiegs, 1922

Included genera: *Protomicrocotyle* Johnston and Tiegs, 1922; *Bilaterocotyle* Chauhan, 1945; *Lethacotyle* Manter and Prince, 1953.

Subfamily Vallisiinae Price, 1943

Included genera: *Vallisia* Perugia and Parona, 1890; *Vallisiopsis* Subhapradha, 1951; *Allodiscocotyla* Yamaguti, 1953; *Pseudomazocraes* Caballero and Bravo, 1955.

26. **The Fish, *Cyprinodon*, as the Intermediate Host for a New Species of the Trematode Genus *Ascocotyle*.** W. Henry Leigh, University of Miami.

An undescribed species of trematode metacercaria of the genus *Ascocotyle* is specific for the conus arteriosus of *Cyprinodon v. variegatus* (Lacepede) in South Florida. Cysts occur in such large numbers that the conus arteriosus is swollen to several times normal size; and when the conus can no longer accommodate them, metacercariae encyst anteriorally in the artery which leads from the conus. It is not unusual to find 600–800 cysts in a single swollen conus. The incidence of infection in the area of collection is nearly 100 percent.

The cysts are quite different from the thin-walled cysts of *Ascocotyle tenuicollis* Price, 1935, and *A. leighi* Burton, 1956, previously reported from the conuses of *Gambusia affinis holbrooki* Girard and *Mollinesia latipinna* Le Sueur, respectively, and are more like those of *A. mcintoshi* Price, 1936, which occur in the viscera of both of the above-mentioned fish species. The cyst walls of metacercariae from *Cyprinodon* are extremely thick and tough and do not digest during their passage through the intestine of day-old chicks. Complete excystation occurs only after they have been taken into the ceca where they become sexually mature.

This trematode is an undescribed species of *Ascocotyle* similar to *A. leighi* even to the extent of having the same number of hooks in the oral sucker, a character relied on for species separation in this genus. Twenty-six hooks occur in each of 2 rows making a total of 52. *A. leighi* was described as having 48–52 hooks. Differences in size of cysts and the enormous difference in the thickness of cyst walls coupled with the complete specificity of these forms for their fish hosts make it apparent that these two similar forms comprise different species.

27. **Observations on Larval Development of the Heterophyid, *Stellantchasmus falcatus*, in Snails.** Kaoru Noda, University of Hawaii.

Laboratory-reared, juvenile *Tarebia granifera mauiensis* Lea snails were allowed to feed on macerated adult *S. falcatus* containing eggs obtained from an experimentally infected cat.

On the 14th day and as late as the 35th day, mother sporocysts were found attached to the mantle tissue which surround the snail intestine. The mother sporocyst was an ovoidal body comprised of several oval compartments, each surrounded by the thin paletot. Within each compartment was a single germinal cell which produced many cells following repeated cleavage. These cells became enclosed within a thin membrane whose origin was not determined.

The daughter sporocyst, which developed at the same site into a thread-like body 1 cm or longer, was found to be merely the elongation with concomitant development of a compartment of the mother sporocyst. Thus, the outer wall of the daughter sporocyst is the original paletot of the mother sporocyst. Around the 68th day following infection, mature mother rediae left the daughter sporocyst and migrated to the digestive gland of the snail. Daughter rediae and cercarial development ensued. Emergence of cercariae from the snail was first noted 123 days after snails were exposed to fluke eggs.

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28. **The Production of F_2 Offspring from F_1 (Hybrids) of *Oncomelania nosophora* and *O. hupensis*.** Y. Komiya and K. Kojima, Department of Parasitology, National Institute of

Health, Tokyo.

Oncomelania nosophora, the vector snail of *Schistosoma japonicum* in Japan, was crossed with *O. hupensis*, the vector snail of that in Continental China, and F_1 offspring were produced in May, 1958. They became adult in October of the same year, and from these F_2 offspring were produced in March, 1959. Thus it is indicated that these snails are not biologically distinct species. That *O. nosophora* and *O. quadrasi* are not distinct species had already been pointed out by E. D. Wagner et al.

29. **Observations on the Life History of *Ornithodoros kelleyi* Cooley and Kohls, 1941 (Acarina: Argasidae).** D. E. SONENSHINE, University of Maryland.

The life history of the tick *Ornithodoros kelleyi*, an ectoparasite of bats, consists of the larva, two to four nymphal stages, the male, and the female. The larvae were fed on bats and white rats. They engorged within 8 to 20 days and then molted within two to six days into first stage nymphs. These nymphs did not feed but molted directly into second stage nymphs within 8 to 18 days. Whereas the nymphs and adults would not feed on rodents, they fed readily on bats and emitted coxal fluid while feeding. The second stage nymphs fed within 20 to 85 minutes and then molted within 11 to 28 days into either males or third stage nymphs. The third stage nymphs fed within 32 to 144 minutes and then molted within 14 to 52 days into either fourth stage nymphs, males, or females. The fourth stage nymphs fed within 33 to 148 minutes and molted into females within 16 to 78 days. The males engorged within 27 to 140 minutes, and the females fed within 25 to 140 minutes. Copulation was observed to occur before or after feeding, and the females oviposited 14 to 218 days after they had engorged. The eggs hatched within 9 to 15 days. The minimum length of the life cycle, under laboratory conditions, was 54 days for the male and 81 days for the female. The longevity of starved ticks was shortest among the larvae and greatest among the females.

30. **The Biology of *Culex tarsalis* Coq. Raised in the Dark at 18° C.** JOWETT CHAO, University of California at Los Angeles.

Three generations of *Culex tarsalis* Coq. have been raised since November 1958 in a dark room at a constant temperature of 18° C. The following are average figures: females feeding after 2 hours, 12 percent; biters laying eggs, 30 percent; number of eggs per egg case, 212; hatching rate, 96 percent; time from blood meal to egg deposition, 9 days; hatching time, 4 days; completion of larval instars, 29 days; pupal stage, 6 days; time from egg deposition to emergence of adults, 39 days.

The corresponding averages for *C. tarsalis* raised at room temperature of about 26° C are: females feeding after 2 hours, 80 percent; biters laying eggs, 50 percent; number of eggs per egg case, 150; hatching rate, 90 percent; time from blood meal to egg deposition, 5 days; hatching time, 2 days; completion of larval instars, 13 days; pupal stage, 2 days; time from egg deposition to emergence of adult, 17 days.

Under experimental condition, the first larval instar had a very high mortality rate. In other respects, the colony seemed healthy. Pupae and adults were larger than the corresponding stages of the colony raised at room temperature.

(This investigation was supported in part by a Grant E-87 to Dr. G. H. Ball, from the National Institute of Allergy and Infectious Disease of the National Institutes of Health.)

31. **Microorganisms Isolated from the Digestive Tract of *Culex tarsalis* Coq.** JOWETT CHAO AND GEORGE WISTREICH, University of California at Los Angeles.

A bacteriological investigation of the digestive tract of laboratory-raised *Culex tarsalis* showed the presence of members of the following genera: *Achromobacter, Aerogenes, Proteus* and *Pseudomonas*. The yeast *Saccharomyces* was also encountered. Antibiotic sensitivity tests were conducted upon each of the bacterial specimens. The majority of microorganisms isolated were found to be sensitive to terramycin, yet only one was found to be susceptible to penicillin.

(This investigation was supported in part by a Grant E-87 to Dr. G. H. Ball, from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health.)

32. **Transovarial Passage of Radioactivity in Ticks Labeled with C^{14} Glycine.** K. E. HYLAND, JR., AND J. L. HAMMAR, University of Rhode Island.

Preliminary to field studies of *Dermacentor variabilis* a consideration of various techniques was undertaken for the internal labeling of adult female ticks, the goal being to pass to the offspring a degree of radioactivity. Female ticks were administered the tracer through a glass capillary tube which was fitted over the hypostome and chelicerae (after the techniques of

Chabaud and of Bergdorfer). The tube was calibrated to accept 0.01 ml of glycine, which contained 0.5 micro-curies of carbon-14. Each tick after imbibing the radioactive glycine was allowed to finish engorging on laboratory rabbits. Eggs and resulting larvae were found to be radioactive although there was a decrease of approximately 55 percent in the activity between egg and larva. Preliminary results indicate that there is no reduction in the egg laying capacity of the females, nor is there a decrease in the hatchability of the radioactive eggs. The effects of carbon-14 on the remainder of the life cycle have not been investigated.

33. **A Three-Year Survey of the Infection Rate of** *Echinorhynchus coregoni* **and** *Cyathocephalus truncatus* **in Their Intermediate Host** *Pontoporeia affinis* **from South Bay Mouth, Ontario.** D. L. DEGIUSTI AND JOHN BUDD, Wayne State University and Ontario Fisheries Research Laboratory.

Apparatus and methods for quantity collection of *P. affinis* have been developed. *P. affinis* have been periodically collected in depths of 75 to 150 feet from a selected area of South Bay Mouth on Lake Huron.

During the three year period (1956–1957–1958), 8,115 *P. affinis* have been examined. The following results were obtained: The overall infection rate with the two parasites during the 1956 season was 7 percent, during the 1957 season, 4 percent, and during the 1958 season, 1.5 percent. Of the total number of amphipods examined, only 8 were found infected with both *E. coregoni* and *C. truncatus*. These 2 parasites occurred as single infections in approximately the same ratio.

The decrease in the overall percentage of infection during the 3-year period may reflect the decrease in the coregonid population of the area; however, this phase of the study needs further analysis.

34. **Fish Hosts of the Caryophyllidea (Cestoda).** J. S. MACKIEWICZ, Cornell University.

Except for *Archigetes* and possibly members of the genus *Brachyurus*, reported as maturing in Tubificidae (ANNELIDA: OLIGOCHAETA), all other caryophyllid worms appear to mature in teleost fish, usually fresh-water. The following summary of fish hosts is arranged according to the system and order of Berg (1940). Numbers of host genera and species respectively are in parentheses.

ORDER: Mormyriformes, SUBORDER: Mormyroidei, Mormyridae (1: 1). ORDER: Cypriniformes, Characinoidei, Characinidae (1: 1); Cyprinoidei, Catostomidae (6: 19), Cyprinidae (26: 36), Cobitidae (1: 1); Siluroidei, Plotosidae (1: 1), Bagridae (3: 3), Clariidae (1: 5). ORDER: Perciformes, Percoidei, Cichlidae (1: 1); Blennioidei, Zoarcidae (1: 1); Gobioidei, Gobiidae (1: 1).

Dominant hosts in the Nearctic region are members of the Catostomidae; in the Palearctic, the Cyprinidae. The Siluroidei appear to be dominant hosts in the Oriental, Ethiopian, and Australian faunal regions. Caryophyllidea have not been reported from the Neotropical region. The highest numbers of host species infected with these cestodes occur in the genera *Catostomus* (Catostomidae) with 7, and *Leuciscus* (Cyprinidae) and *Clarias* (Clariidae) each with 5. Most of the incidence records are from inland, fresh-water environments, however, those from the Zoarcidae (*Zoarces viviparus* L.) and Gobiidae (*Gobius minutus* Pall.) are from the Baltic Sea, Bay of Danzig.

35. **Development of Epidermal Glands and Enclosing Membranes of a Dilepidid Oncosphere.** R. E. OGREN, Dickinson College, Carlisle, Pa.

The hexacanth embryo of *Dilepis undula* Schrank has prominent granular glands in the mature conditions. They arise from paired primordia behind the immature hooks. They form a U-shaped area in active mature oncospheres and in retracted post-mature condition they are C-shaped. The granules of the gland stain purple with toluidine blue and are Schiff-positive. The stain intensity increases in older oncospheres.

There are three basic envelopes enclosing this oncosphere: (1) The outer shell capsule develops from vitelline cell products, but is not completed until the oncosphere is in the post-maturation condition. It is a sclerotin-like protein. (2) The subshell region appears prominently after the oncosphere has developed and is viscous, metachromatic region. (3) The inner capsule appears during oncosphere development in association with certain macromeres. It changes from a thin granular envelope to a thick rigid, transparent capsule closely associated with the oncosphere.

36. **Experimental Autoreinfection of** *Hymenolepis nana* **in Isolated Mice Restrained from Coprophagy.** D. HEYNEMAN, University of California, Los Angeles.

A series of infections with single cysticercoids of *Hymenolepis nana* was undertaken to test the hypothesis that reinfection of this worm can occur within its final host. An earlier report (Heyneman, 1953, J. Parasit. **39** (supp.) : 28) described occasional heavy reinfections found in mice fed 30 cysticercoids and autopsied 21 days later. However, this left the mode of reinfection unresolved. Since the eggs of *H. nana* are viable on passing from the host, they may be reingested in feces and produce a second generation of worms without actually having remained within the gut of the rodent host. Hence, special restraining cages were constructed in which individual mice were confined in such a way as to prevent coprophagy and permit the mouse free access to food and water. Each animal was fed one cysticercoid prior to being placed in its isolation cage. Control animals were also infected with a single cysticercoid but were allowed to mingle together in a standard cage. At the conclusion of the appropriate time interval all animals were sacrificed and tested for worm reinfection by counts of adult worms in the lumen and/or cysticercoids in the villi. In a series of four such experiments, involving 69 isolated and restrained mice and 34 grouped controls, autoreinfection was clearly indicated in 43 (63 percent) of the restrained mice and in 29 (68 percent) of the controls. Both intensity, duration, and percentage of infection support the view that autoreinfection with *Hymenolepis nana* in restrained isolated animals occurs to nearly the same degree that it is found in grouped animals where coprophagy and mutual contamination are permitted.

37. **A Population of Branched Tapeworms (*Hymenolepis nana*) Found in a Strain of DBA-1 Mice.** D. Heyneman, University of California, Los Angeles.

A highly abnormal strain of *Hymenolepis nana* has been discovered in a colony of DBA-1 mice maintained locally by a commercial laboratory animal supplier. The primary abnormalities noted are branched strobila (1–5 branches per worm) and inverted proglottid sequence. Branches have been found to vary from a nubbin of lateral undifferentiated growth between adjacent segments, to a completely developed branch producing a forked tapeworm, with both branches bearing gravid proglottids. As many of five distinct branches have been seen on a single worm. Branches may occur anywhere from the neck region to the end of the worm. Reversal of segmentation has been seen, which appears to be due to a growth region appearing at the end of the worm, which produces a new, terminal growth center which subsequently buds off new immature segments. Control of strobilization, normally confined to the neck region, seems to occur spontaneously at various points along the worm, as is seen by the innumerable small projecting buds of growth along the affected worm margins, which occasionally develop into true branches. Approximately 5 percent of the 1500 worms examined thus far were affected. Attempts to establish a pure strain of the branched worms in the laboratory have so far failed. Further, no branched worms have yet been recovered from any mouse strain other than the purchased DBA-1 animals. Other strains of mice from the same supplier are also infected with *H. nana*, but show no branched worms. It has not therefore been possible to establish as yet whether this aberration is a true genetic mutation or a remarkable growth effect induced by a specific host strain.

38. **Minimum Development Compatible with Infectivity in the Larval Stages of *Spirometra mansonoides*.** Justus F. Mueller, State University of New York, Upstate Medical Center, Syracuse, N. Y.

Although the life history pattern of dibothriocephalid tapeworms has long been known, little information is available on the time required by the larval stages to complete development in their respective hosts. It is commonly stated that the procercoid is infective after 21 days, while Mueller (1938) pointed out that sparganules 3 to 4 mm in length, recovered from mice only 2 or 3 weeks after feeding procercoids, were already infective for cats.

Random observations during several years of intensive work with *Spirometra mansonoides*, indicated that overwhelming infections (200–500 worms per mouse) can be produced in young mice by feeding 14 day old procercoids; and uniformly massive infections (50 or more per mouse) with 13- to 9-day procercoids. Occasional infections (from 3 to 50 spargana per mouse) have been produced with 8-day procercoids, and on one occasion similar results were obtained with 7-day procercoids, reared at room temperature (75–80° F). Finally a critical experiment was conducted. A copepod culture, maintained at approximately 76° F, was infected, and divided into 4 portions. Beginning with the 4th day, each portion in turn was fed to four 10-gram mice (i.e., procercoids 4, 5, 6, 7 days old). The mice were examined 10 weeks later. Two mice from the 7-day lot were positive, with small spargana in the muscles; the others were negative. Thus it appears that procercoids, at the temperature of the experiments, become infective in mass, after 9 days in the copepod, and some, at least, after as few as 7 days.

To determine the minimum development necessary for infectivity of the sparganum, a series of mice were fed procercoid-bearing copepods (21-day infection), and the individual mice fed

to worm-free cats at intervals of one-half day, from 12 hours to 108 hours, and at intervals of 1 day, from 4 days to 10 days. All cats, from 108 hours up, became infected, with prepatent periods of from 11 to 26 days. The prepatent period of the cat receiving the 108-hour mouse was 17 days. Thus it is clear that essential development of the plerocercoid is complete after as short a period of 4½ days in the mouse. Sparganules at this time are only 0.5 to 1.0 mm long, and are still lodged in the wall of the alimentary canal.

Although very young procercoids and plerocercoids are able to produce infections, some stunting from these precocious transfers results, since the ensuing sparganum is retarded in growth, and the prepatent period of the adult worm is unusually long.

(Supported by grants from the Research Foundation of the State University of New York, and the National Institutes of Health.)

39. **Substitution of a Cell-Free Culture System for the Second Intermediate Host in the Life Cycle of** *Spirometra mansonoides.* JUSTUS F. MUELLER, State University of New York, Upstate Medical Center, Syracuse, N. Y.

A year ago, at these meetings (paper No. 10), the author reported the in vitro cultivation, in a cell-free medium, of the sparganum of *Spirometra mansonoides* to the infective stage. It was demonstrated that procercoids, removed from copepods, could be grown in culture to considerably more than the minimum size necessary for infection of the definitive host. Such cultured larvae were fed to cats, but insufficient time had elapsed, at the date of reporting, to determine the outcome. At the same time, it was recorded that a number of infections had been produced in cats with cultured larvae, but these larvae had been started in mice, and thus failed to meet the requirements of a critical experiment.

It can now be reported that numerous procercoids, removed from copepods by a special technique, have been axenically reared to the plerocercoid stage in Mixture 199, calf serum, and chick embryo extract, to a length of approximately 20 mm in 60 days, and have been fed to worm-free cats. Nine infections were produced in 9 attempts. The adult worms obtained were normal, and produced large numbers of eggs. These eggs have been collected, hatched, and have produced normal infections in copepods, and finally in mice. Thus the criteria of successful in vitro cultivation, as laid down by Smith, 1955, have, for the first time, been met.

It is thus conclusively demonstrated that a cell-free culture system can support normal growth and differentiation of the sparganum larva, and can replace entirely the second intermediate host in the life cycle of the worm.

(Supported by grants from the Research Foundation of the State University of New York, and the National Institutes of Health.)

40. **Temperature Stress and Development of** *Hymenolepis diminuta* **in** *Tribolium confusum* **on Different Diets.** M. VOGE, University of California, Los Angeles.

Exposure of *Hymenolepis diminuta* to high temperature during the sensitive period of development results in failure of scolex withdrawal in at least two-thirds of the cysticercoids and inhibits infectivity in those which appear morphologically normal. By feeding the intermediate host, *Tribolium confusum,* certain pure sugars instead of flour, the incidence of morphological abnormalities in cysticercoids is markedly reduced and percent infectivity of morphologically normal cysticercoids increased. Results obtained show that both moisture and certain sugars in the host diet act independently or in combination to influence cysticercoid development. When flour beetles are fed on saturated sugar solutions during the total period of cysticercoid development, temperature stress during the sensitive period results in only one-third or less abnormal cysticercoids as compared to two-thirds or more when adult beetles or beetle larvae are fed on flour.

41. **Kinetics of Amino Acid Penetration in Tapeworms.** C. P. READ, J. E. SIMMONS, AND A. H. ROTHMAN, The Johns Hopkins University.

The penetration of L-valine-C14 and L-leucine-C14 into the dogfish tapeworm, *Calliobothrium,* has been investigated. The permeation in each case follows first order reaction kinetics during a 7-minute period. In remaining experiments incubations were 120 seconds. The apparent Michaelis' constant for L-valine at 10° C is 4×10^{-4} and for L-leucine it is 1×10^{-3}. A Lineweaver-Burke analysis shows that permeation of L-valine is competitively inhibited by L-leucine and that of L-leucine is competitively inhibited by L-valine. Permeation of 3.3×10^{-3}M L-valine is inhibited by the following amino acids at concentrations of 6.6×10^{-3}M: L-proline, glycine, N-acetyl-DL-valine, DL-serine, D-leucine, L-alanine, DL-methionine, and L-cysteine. The permeation of L-valine is not inhibited by L-tryptophan, L-histidine, glutanic acid, L-arginine, DL-phenylalanine, D-valine, and L-isoleucine, but is stimulated by L-Lysine. The accumulation of L-valine and L-leucine is not affected by the addition of glucose but markedly inhibited

by iodoacetate, fluoride, and dinitrophenol if the worms are previously incubated in the presence of inhibitor. It is concluded that L-valine and L-leucine pass from the external medium into *Calliobothrium* by a process involving adsorption which is probably dependent on an intact energy metabolism for its operation. Observations on *Lacistorhynchus* (order TRYPANORHYNCHA) suggest that similar processes are involved in penetration of amino acids.

(This work was supported by a U. S. Public Health Service grant, E-1508 (C-1)).

42. **The Uptake of Glucose by *Hymenolepis diminuta*.** KENNETH PHIFER, The Johns Hopkins University.

A study of glucose uptake by *Hymenolepis diminuta* was carried out, utilizing both 30-minute incubations in unlabelled glucose and 60-second incubations in C^{14}-labelled glucose. The effects of several physical, chemical and physiological factors on this uptake were studied.

It was found that linearity of glucose uptake with glucose concentration does not obtain above a certain level. The apparent Michaelis constant for the uptake of glucose was calculated to be from 1.5×10^{-3}M to 1.6×10^{-3}M. Studies on the effect of temperature showed that Q_{10}'s for this process were not of the order of those seen in typically physical processes. It was shown that heating worms greatly reduced the level of glucose uptake in 30-minute incubations, and that the glucose uptake of heated worms was not affected by iodoacetate.

Apparent accumulation of glucose against a concentration gradient was demonstrated and it was also shown that when placed in a glucose-free solution, the worms lost no appreciable quantity of glucose.

It was demonstrated that iodoacetate, dinitrophenol, para-chloromercuribenzoate, sodium taurocholate and phlorizin reduced the level of glucose uptake by these tapeworms. *H. diminuta* takes up glucose at a faster rate on the twelfth day after infection than at any other time in its development in the rat host; and it was shown that the rate of uptake of glucose by this tapeworm was directly proportional to the weight of the tissue over a wide range. Also, it was seen that there is a gradient of uptake activity in the worm. The anteriormost portion of the worm was found to take up glucose at a higher rate than were the posterior segments of worm tissue.

The data are briefly discussed in terms of host-parasite competition for glucose.

(This study was carried out under the direction of Dr. Clark P. Read and was supported by a U. S. Public Health Service Pre-Doctoral Fellowship.)

43. **The Physiology of Tapeworms, Correlated to Structures Seen with the Electron Microscope.** ALVIN H. ROTHMAN, Johns Hopkins University, School of Hygiene and Public Health.

To date there has been little investigation of cestode ultrastructure. Some observations on the fine structure of *Hymenolepis diminuta* and a proposed correlation between structure and function will be offered. Flame cells were observed in every region of the tapeworm from the neck to the gravid portion. The flame cell cilia have the typical pattern of fibril distribution, observed in cilia and flagella throughout the animal kingdom. The sperm flagellum also have this fibril pattern. The surface of the tapeworm is covered with projections which are called microtriches (singular microthrix). Microtriches are absent or very scarce only on the most anterior portion of the scolex. They have a central cavity, a dense cortex, and taper distally. Proximally they are associated with what has been termed the "cuticle." However, cuticle is a misnomer for this structure, because this organ is not inert; it reduces tetrazolium and numerous mitochondria are seen distributed within its matrix.

The term tegument seems preferable to cuticle, because the former designation does not bear the connotation of non-living. The microtriches from the neck to the gravid region are all about the same size. From .10 to .16 micron wide and from .70 to 1.0 micron long. The cavity of the microthrix occupies only about the proximal half. The microtriches increase the surface area of the tapeworm considerably. They also alter the surface to cross sectional area relationship so that the ratio in the middle region of the worm exceeds that of the posterior region and more closely approaches that of the anterior region. This change in the relative surface fits the available data on the rate of substrate absorption by this tapeworm. The tegument is permeated with what have been called pore canals by the early German workers. Whether these canals unite with the medullary cavity of the microthrix is conjectural and not yet demonstrated. These pore canals may open directly to the environment and connect the outside with the parenchyma by means of large ducts observed to pass from the inner border of the tegument through the subtegument and then branch and disappear into the tapeworm tissue. Further observations are necessary to understand the operation of the tegument in relation to the microthrix and the structural relationships that exist in the parenchyma of the worm. Such studies are in progress.

(This work has been supported by U. S. Public Health Service Grant No. 1508-C1.)

44. **A Procedure for Comparative Studies of Mutagenesis in Cestodes.** E. L. SCHILLER, The Johns Hopkins University.

The knowledge that ionizing radiations greatly increase the rate at which the usual variant characters are expressed in a number of different organisms has been applied recently in this laboratory to an experimental study of the nature, extent and directional trends of morphological variation in tapeworms of the genus *Hymenolepis*. Descriptive data have been accumulated relative to the nature and extent of intraspecific variation and the qualitative and quantitative effects of X-irradiation in *H. nana*. An improved experimental design has been developed which shows promise, not only for obtaining information concerning the effects of ionizing radiations and chemical mutagens on invertebrate tissue and for the testing of agents which afford protection against these effects, but also on how characters are inherited in these organisms.

Tapeworms, *H. diminuta*, are obtained at autopsy of experimentally infected laboratory rats. The scolex, including a small portion of the "neck" is removed, subjected to the desired treatment (X-irradiation, chemical mutagens, etc.) and is then surgically implanted in the duodenum of another helminth-free rat, where development of a new strobila occurs. The original strobila is then prepared as a whole-mount and serves as the untreated material with which the strobila developing after treatment is compared. After the desired time in the recipient host, the treated individual is recovered at autopsy and its new strobila is similarly prepared for determination of the effects of the treatment by direct comparison with its original strobila. When desired, the scolex can again be removed before fixation and re-implanted. This can be repeated until a large series of strobilae has been obtained from the same individual. By allowing sufficient time (18 days) for the treated individual to become gravid and using the eggs for the establishment of subsequent experimental infections, morphological and biochemical comparisons can be made with the sexual progeny over a number of generations to determine whether the observed effects are inherited.

This procedure has been employed successfully in this laboratory in experimentation with *H. diminuta*. Data resulting from studies on the transmissibility of morphological effects produced by different doses of X-irradiation and from the investigation of the mechanism of proglottidization are presented.

(This work has been supported by a U. S. Public Health Service Grant No. E-1508 (C1).)

45. **Preliminary Experiments on the Growth of a Cyclophyllidean Cestode in vitro.** E. L. SCHILLER, C. P. READ AND A. H. ROTHMAN, The Johns Hopkins University.

Adults of *Hymenolepis diminuta* were removed from the rodent host. The scolex and a small portion of the "neck" were severed from the strobila and washed in several changes of sterile Ringer's solution and finally in Gey's solution containing streptomycin and penicillin. Each worm was inoculated into a roller tube containing test medium and placed in a roller drum at 38° C. Growth of worms occurred in 50 percent horse serum—Gey's solution with glucose, 50 percent serum ultrafiltrate—Gey's solution with glucose and in a synthetic mixture of vitamins, amino acids, purines, pyrimidines, salts and glucose. Addition of an extract of cestode tissue to 50 percent horse serum gave best growth with a 30-fold increase in size by the eleventh day. Strobilization occurred in most media. As many as 130 segments formed with some differentiation of reproductive organs, in the best medium. Data on growth in size and increase in total nitrogen will be presented.

Five worms from 11-day cultures were surgically implanted singly in clean rats. At autopsy 3 of the 5 rats contained a single normal *H. diminuta*.

(This work was supported by a U. S. Public Health Service Grant, E-1508 C1.)

46. **Studies on the Cestode Genus *Marsipometra* Cooper (Pseudophyllidea: Amphicotylidae).** FRED P. MEYER AND MARTIN J. ULMER, Iowa State College.

Examination of 700 live paddlefish (*Polyodon spathula*) collected in 1958 from the Mississippi and Missouri Rivers indicates the doubtful validity of 1 or more of the 3 species of *Marsipometra* previously described. Gravid worms from live fish differ morphologically from those removed from paddlefish killed some hours previously. Worms in dead hosts migrate rapidly from their normal site and move to the stomach, esophagus, caeca, or even to external surfaces of the fish. Such abnormal specimens may resemble certain of the described species.

From a large number of normal worms recovered from a live fish, one group was refrigerated at 32° F for 4 hours, with some worms kept in river water, some in physiological saline, and some in host tissue fluid. A second group was similarly treated, but not subjected to refrigeration. A third group of worms was left in unopened fishes, some of which were refrigerated, others kept at room temperature. Worms from the 1st and 2d groups became distorted, save for those maintained in physiological saline. Distortion was less pronounced in refrigerated

specimens. Striking variations in size and shape of scoleces and of proglottids characterize distorted individuals. Refrigeration caused no apparent differences in worms from the 3d group, though migration of the cestodes within the host was extensive.

Comparisons of variously treated worms with those described in the literature show that examples of all 3 "species" occur, in addition to several forms which might be construed as new species. Serial sections of adult worms indicate that within a single strobila, individual proglottids may occur, identical to those formerly described as distinct and separate species. Further studies on adult worms and investigations on the life cycle are in progress.

(These studies are supported in part by a grant from the National Science Foundation.)

47. **Studies on the Serology of Echinococcosis.** IRVING G. KAGAN, LOIS NORMAN AND DOROTHY S. ALLAIN, Communicable Disease Center, Public Health Service, Atlanta, Georgia.

Serological studies employing the tannic acid hemagglutination and the bentonite flocculation tests were made with a variety of *Echinococcus granulosus* and *Echinococcus multilocularis* antigens. Hydatid fluid, scolices and membrane antigens of *E. granulosus* from naturally infected pigs, and hydatid fluid, scolices and cyst antigens of *E. multilocularis* from laboratory infected cotton rats were used. Antisera against these antigens were prepared in rabbits. Sera from patients with surgically proved *E. granulosus* infections and from individuals believed to be infected with *E. multilocularis* were evaluated for specificity. Both hydatid fluid of *E. granulosus* and cyst antigen of *E. multilocularis* were fractionated with trichloracetic acid and the various fractions tested for specificity. Of all the antigens employed in the tests, hydatid fluid of *E. granulosus* proved to be the best antigen in both the hemagglutination and flocculation tests. None of the antigens were species specific. Scolices antigens were the least specific of all the antigens tested. Trichloracetic-sodium hydroxide soluble fractions of *E. granulosus* hydatid fluid and *E. multilocularis* cyst antigen were more sensitive than the original antigens in the serological tests employed. They also showed higher nonspecific titers with normal host organ antisera. Little to no species specificity was demonstrated by the purified antigens.

48. **The Life Histories of the Two Species of *Echinococcus* of Man.** T. B. MAGATH AND J. H. THOMPSON, JR., Mayo Clinic and Mayo Foundation.

The complete life histories of the two species of *Echinococcus* of man have been carried out and photographed in Kodachrome. The life history of *Echinococcus multilocularis* was carried out in voles, white mice and rats in the larval stage and in foxes and dogs as definitive hosts. The life history of *Echinococcus granulosus* was photographed from live material from man, hogs, sheep, and dogs. In addition there is included some film showing the removal of a cyst from man, the diagnostic tests available, and some phases of the immunology of the disease. The running comments on the sound track were prepared and voiced by Dr. T. B. Magath.

49. **Physiologic Studies on the Larval and Adult Scolex of *Spirometra mansonoides*.** JUSTUS F. MUELLER, State University of New York, Upstate Medical Center, Syracuse, N. Y.

Although morphologically similar, marked physiological differences exist between the larval and adult scoleces of *Spirometra mansonoides*. Larval scoleces survive storage in tissue, or culture medium, for an indefinite period at 4° C, but the adult scolex is quickly killed by such treatment. The larval scolex can be maintained in culture medium at 37° C for as long as a year and can be grown from the procercoid, but the adult, in the same medium, survives no more than a month. Introduced into the anterior chamber of the rabbit's eye, the larval scolex continues to grow for a month or more. But the adult scolex, similarly treated, is quickly killed and absorbed. The adult scolex is unable to survive stomach passage a second time, but the larval scolex can do so repeatedly.

In contrast to *D. latum* and its relatives, the sparganum of *Spirometra*, fed to cats, sheds most of its body, and only 7 or 8 mm of the head end remains to produce the adult worm, as first reported by Joyeux and Baer, 1931. Injection of large spargana into the duodenum of cats, via laparotomy, did not alter this pattern of development, nor did it prevent establishment of normal infection.

Mueller (1938) showed that the adult scolex, implanted under the skin of mice, may continue to grow and segment, but will not revert to the larval form. To determine exactly when this irreversible change occurs, cats were fed varying numbers of spargana, and the intestinal mucosa searched for scoleces at intervals from 1 to 7 days later. The small scoleces recovered were observed in culture for several days, and then injected into mice. At any time preceding the 4th day the scolex reverts to the sparganum in the mouse. But from the 4th day on it is unable to do so. Occurrence of this critical point is coincident with formation of the first segments.

All attempts to date to induce differentiation of the larval to the adult scolex in vitro have failed.

(Supported by grants from the Research Foundation of the State University of New York, and the National Institutes of Health.)

50. **Interaction Between Dietary Carbohydrate Quality and Quantity in Nutrition of *Hymenolepis diminuta*.** JOHN C. HOLMES, The Rice Institute.

Read and Rothman (Exp. Parasit. **6**: 1–7) reported differences in the weight attained by *Hymenolepis diminuta* due to the quality of the host's dietary carbohydrate. Similar differences were not obtained with worms from rats maintained on diets containing 68 percent carbohydrate. An experiment was therefore designed to test possible interaction between dietary carbohydrate quality and quantity in the nutrition of this tapeworm.

Groups of 5 140–160 gram male Holtzman rats were given 5 *H. diminuta* each, then placed on experimental diets containing high (68 percent) or low (34 percent, plus 34 percent cellulose) quantities of starch, glucose or sucrose as the sole dietary carbohydrate. The rats were allowed to feed *ad libitum*. At harvest 3 weeks later the mean wet weights of the worms were: (1) high starch, 724.8 ± 46.8 mg; low starch, 480.0 ± 40.8 mg; (2) high glucose, 773.4 ± 37.8 mg; low glucose, 142.8 ± 31.7 mg; (3) high sucrose, 403.2 ± 37.8 mg; low sucrose, 32.6 ± 8.0 mg. At the high level used, the superiority of starch over glucose as a carbohydrate source for the tapeworms was obliterated and sucrose became a reasonably satisfactory carbohydrate source. Worms from rats on low sucrose diets were essentially the same as those Read and Rothman (Exp. Parasit. **6**: 294–305) found in rats totally deprived of carbohydrate.

(This work was supported, in part, by Research Grant E-1384 from the National Institute of Allergy and Infectious Diseases, National Institutes of Health.)

51. **Competition for Carbohydrate between the Rat Tapeworm, *Hymenolepis diminuta*, and the Acanthocephalan, *Moniliformis dubius*.** JOHN C. HOLMES, The Rice Institute.

Previous reports (J. Parasit. **43** (supp): 24; **44** (supp): 15) have summarized the inhibitory effects of concurrent infection on *Hymenolepis diminuta* and *Moniliformis dubius*. The present report summarizes the results of two groups of experiments designed to determine the mechanism underlying these effects.

Groups of 15 Holtzman rats, 10 infected with 10 *M. dubius* 5 weeks previously, were placed on experimental diets containing 50 percent starch, 68 percent starch, 68 percent glucose or 68 percent sucrose as the sole carbohydrate. A similar group was placed on a chow diet. Two days later half of the infected rats, and all of the previously uninfected ones, were given 5 *H. diminuta* cysticercoids. At autopsy 4 weeks later the *H. diminuta* from concurrent infections on the chow and glucose diets, both male and female *M. dubius* from concurrent infections on the chow diet, and female *M. dubius* from concurrent infections on the glucose diet were significantly lighter, shorter, and had lower weight/length ratios than control worms from single infections. Worms from concurrent infections on the starch and sucrose diets did not differ from controls.

In a second series of experiments, groups of 32 rats were infected with 5 *H. diminuta*, 10 *M. dubius*, or 5 *H. diminuta* plus 10 *M. dubius*. Starting 25 days later half of the rats in each group were given daily subcutaneous injections of a 10 percent suspension of phlorhizin in sesame oil, at the rate of 0.2 cc/100 grams body weight. All worms were harvested 10 days later. Tapeworms from single infections in animals given phlorhizin showed significant increases in weight over those from control animals. In 7 of 16 phlorhizin-treated rats given concurrent infections, the tapeworms were identical in weight to those from phlorhizin-treated rats with single species infections.

The data indicate that increased quantities of utilizable carbohydrate in the gut of the host alleviates the effects of concurrent infection, and suggest that the mechanism behind these effects is competition for carbohydrate.

(This work was supported, in part, by Research Grant E-1384 from the National Institute of Allergy and Infectious Diseases, National Institutes of Health.)

52. **Parasites of Commercial Shrimp.** DWAYNE N. KRUSE, Florida State University.

Three species of commercial shrimp (*Penaeus aztecus* Ives, *P. duorarum* Burkenroad and *P. setiferus* Linnaeus were examined for parasites. The shrimp were collected in the summer and fall of 1958 from the northwest Gulf coast of Florida. The following parasites were recovered: metacercariae of *Opecoeloides* encysted in the tissue surrounding the stomach and digestive gland; 3 new species of trypanorhynchan larvae encysted in the digestive gland; an unidentified cestode larva from the lining of the mid-intestine; immature nematodes, *Contracae-*

cum sp., in the digestive gland and tissue surrounding the stomach; 2 gregarines, *Nematopsis penaeus* Sprague and a representative of a new genus, from the intestine and stomach respectively; and a microsporidian, *Thelohania* sp., in the musculature. The taxonomy, morphology, incidence, and biology of these parasites will be discussed.

53. **Occurrence of *Cephenemyia jellisoni* In a Sample of Montana Mule Deer.** KENNETH J. CAPELLE, U. S. Fish and Wildlife Service, Sacramento, and CLYDE M. SENGER, Montana State University, Missoula.

A sample of 40 mule deer in Missoula County, Montana, were autopsied and examined for the presence of the deer nasal bot *Cephenemyia jellisoni*. Bots were recovered from each of the 9 monthly samples. Deer were not examined for bots during July, August, and September. Seventy-five percent of the deer were parasitized with an average of 27 bots per animal.

In some cases the trachea was tied off directly after death to limit migration of the larvae. A significantly high percentage of first instar larvae was found in the trachea and lungs, suggesting their normal occurrence in these areas. First instars were never attached as were second and third instars, but normally were free and migrating over the mucous membranes. They occurred in the lungs or trachea during October, November, December, January, February, March, and April, but were absent in May and June.

Second and third instar larvae favored the retropharyngeal pouches of the head and, unless disturbed, were attached by their oral hooks. Destruction of host tissue in the pouches was noted in 7 deer. It was not noted elsewhere. Three larvae taken in April and May were sufficiently developed to pupate and subsequently emerge as adult flies.

One animal taken in November harbored 256 larvae in the trachea and lungs, all of the first instar. Advanced age and poor health in this case were apparently factors in the unusually high incidence of the parasites.

54. **Louse-Flies from Mule and White-Tailed Deer in Western Montana.** CLYDE M. SENGER, Montana State University, Missoula, and KENNETH J. CAPELLE, U. S. Fish and Wildlife Service, Sacramento, California.

Louse-fly examinations were made on 51 mule deer collected in Missoula County, Montana, during 1958 and in 9 white-tailed deer, *O. virginianus ochrourus*, from western Montana during 1957–58. Fifteen mule deer and 3 white-tailed deer were infested with both *Lipoptena depressa* and *Neolipoptena ferrisi*. In addition, 16 mule deer and 2 white-tailed deer harbored only *L. depressa*, and 1 mule deer only *N. ferrisi*. Twenty-six percent (105 of 404) of the randomly collected keds from mule deer were *N. ferrisi*, but these represented 33 percent of the keds from hosts infested with both species. *Neolipoptena ferrisi* was the predominant species in 6 of the 15 mixed infections. Twenty-two percent (19 of 85) of the keds from white-tailed deer were *N. ferrisi* representing 32 percent of keds in mixed infections.

Both species of keds were abundant on mule deer during January and February, were scarce from March to June, and were not noted in late July. Larval development was noted in *L. depressa* from January to June and in *N. ferrisi* during January and February. Winged and wingless forms which had not yet fed as well as reproducing forms of both species were noted the first week in September. Very few keds were noted from late September to December of 1958, which seemed unusual in view of the abundance of keds in January and February of 1958.

Forty-five percent of the *L. depressa* and 48 percent of *N. ferrisi* were males, but males were not as numerous in the June collection as in previous collections.

55. **On the Life History of Three Species of Hippiboscids Occurring on Ontario birds.** G. F. BENNETT, Ontario Research Foundation, Toronto 5, Canada.

The life histories of *Ornithoica vicinia, Ornithomyia fringillina* and *Lynchia americana* were studied following their capture and removal from wild birds. During 1957 and 1958, about 2200 birds of 81 species were examined for louse flies in Algonquin Park, Ontario. The first hippoboscids (*O. fringillina*) were taken in mid-July, and following this time, 20 percent of the birds examined harboured *O. vicinia* and *O. fringillina*. More flies were found on juvenile than adult birds. *O. fringillina* occurred on 43 species but was predominant on the sparrows and thrushes; no particular preference was noted for *O. vicinia*. *L. americana* was recovered from 5 owls and a hawk during this study.

Female *O. fringillina* and *O. vicinia* were maintained for 60 days and *L. americana* for over 100 days on captive birds. Males were kept for a much shorter period. All three species produced puparia at 5 ± 1 day intervals. Time for metamorphosis varied for each of the species: *L. americana* emerged in about 36 days, *O. vicinia* in about 80 and *O. fringillina* in about 110

days at 75° F. Maintenance of puparia at room and refrigerator temperatures indicated a diapause condition for *O. fringillina*. *L. americana* and *O. vicinia* did not emerge when maintained at 85° F. Females were fertilized soon after they emerged and, apparently, no further mating is required. Some aspects of the behaviour of the adults have been studied.

56. **Blood Parasites of Birds in Algonquin Park, Canada, and a Discussion of their Transmission.** G. F. Bennett and A. M. Fallis, Ontario Research Foundation, Toronto 5, Canada.

The incidence of blood parasites in 1954 adult and juvenile birds of 80 species examined during the summers of 1957 and 1958 was as follows: *Leucocytozoon*, 39 percent; *Trypanosoma*, 29 percent; *Haemoproteus*, 14 percent; *Microfilaria*, 4 percent; *Plasmodium*, 1 percent. Differences in the occurrence of the various parasites in birds, different species and age are compared with the kinds of blood-sucking diptera known to feed on them. Infections in juvenile birds indicated that transmission of *Leucocytozoon*, *Trypanosoma* and *Haemoproteus* began early in June and continued for several weeks. This coincided with the period when ornithophilic simuliids and heleids were abundant and preceded the capture of most hippoboscids. Stages of development of *Leucocytozoon* have been seen in several black flies in sub-genus *Eusimulium* and in *Simulium rugglesi* and *Prosimulium decemarticulatum*. Sporozoites of *Haemoproteus* were seen in 3 species of *Culicoides* that had fed on birds infected with *Haemoproteus*. Developing trypanosomes occurred in all these species of simuliids and heleids. The evidence leads us to expect that heleids rather than hippoboscids are vectors of *Haemoproteus* in this area and that simuliids are important hosts of *Trypanosoma* as well as *Leucocytozoon*.

57. **Preliminary Report on the Haemoparasites of Rodents of Lake Bonneville Basin, Utah.** John C. Frandsen and A. W. Grundmann, University of Utah.

In the summer of 1957 a survey of the helminths and haemoparasitic protozoa of the rodents of the Lake Bonneville Basin was begun. Smears of heart blood were taken immediately after death of the animal. A species of *Plasmodium* has been found in *Eutamias minimus* from widely separated localities. *Trypanosoma* has been found in *Peromyscus maniculatus* and *Eutamias minimus*. *Grahamella*-like inclusions have been found in red cells of *Perognathus parvus*, *Peromyscus truei*, and *P. maniculatus*. *Diplococcus*-like inclusions, staining uniformly with Giemsa's stain, have been found in erythrocytes of *Eutamias minimus*. These inclusions may be similar to those reported from Africa by Schwetz and Collart in 1930. Cigar-shaped objects staining red-violet with Giemsa's stain and showing various spherical inclusions have been found free in the blood of several species of mice. They range in size from approximately 0.9×4.0 microns to 1.0×20.0 microns. Identification has not been possible, and lantern slides of these are included. Examination thus far of blood of *Thomomys bottae* and *T. talpoides* has revealed no parasites.

(This work has been supported by a grant from the National Science Foundation and by the University of Utah Research Council.)

58. **Epizootics of Fish Lice, *Argulus biramosus*, in Two Lakes of Eastern South Dakota.** Marvin O. Allum and Ernest J. Hugghins, South Dakota State College, Brookings.

A severe epizootic of fish lice (*Argulus biramosus* Bere) occurred at Brant Lake, Lake County, South Dakota, in June and July, 1956, with high fish mortality. Nearly all species of fish were attacked, including the white sucker (*Catostomus commersoni*), carp (*Cyprinus carpio*), black bullhead (*Ictalurus melas*), yellow perch (*Perca flavescens*), and walleye (*Stizostedion v. vitreum*). An investigation of the outbreak was conducted by the authors. Distressed and dying fish were dipped from the water for examination. As many as 805 argulids were found on a single 19-inch fish, and counts of from 300 to 400 argulids per fish were common. The skin of most of the fishes was inflamed in the areas of principal infestation, i.e., around the bases of the dorsal, anal, and caudal fins. In many cases, there was apparent cytolytic damage to the dermal scale pockets so that the scales were loosened and could easily be removed. A number of the fish had secondary infections of water mold (*Saprolegnia* sp.), but we do not believe this to be a primary contributor to mortality since many dying fish were observed which were not visibly affected by the fungus.

There was definite evidence of species selectivity by the argulids. For the most part, only one species of fish was heavily attacked at a time, with attacks shifting to another species as the first become reduced in numbers. Eggs of *Argulus* were found on submerged snags. Some of these were transferred to aquaria, where the eggs hatched and larval stages were observed.

A second major infestation occurred in Lake Poinsett, Hamlin County, in June of 1958, differing from that of Brant Lake in severity and kinds of fish affected. In this case, there

was mass mortality of only 1 species, the largemouth buffalo (*Ictiobus cyprinella*). As at Brant Lake the fish had inflamed lesions, but they had in addition extensive growths of fungus on their bodies, and in many cases the fins were frayed and almost gone.

Appreciation is expressed to Mr. T. E. Bowman of the U. S. National Museum for identification of the fish lice.

59. **Lernaeids and Lernaeopodids (Arthropoda: Eucopepoda) from Fishes in Eastern South Dakota.** ERNEST J. HUGGHINS, South Dakota State College, Brookings.

"Anchor worms" (*Lernaea cyprinicea*) were found in the flesh of a number of fathead minnows (*Pimephales promelas*) and white suckers (*Catostomus commersoni*) taken from the Bix Sioux River in eastern South Dakota. This is the first report of this parasitic copepod in South Dakota. Specimens were identified by Mr. T. E. Bowman of the U. S. National Museum. The previously known range of this parasite has been extended westward by several other recent reports. Cook (Colo. Dept. Game and Fish Publ., 1954) reported it as *Lernaea carassii* in Colorado. Haderlie (Univ. Calif. Publ. Zool. **57**: 303–440, 1953) found the parasite to be widespread in California; he called it *L. carassii*, but pointed out the possibility that it might be synonymous with *L. cyprinacea*. Uzmann and Rayner (J. Parasit. **44**: 452–53, 1958) indicated that both *L. elegans* Leigh-Sharpe, 1927, and *L. carassii* Tidd, 1933, are synonyms of *L. cyprinacea* Linnaeus, 1758. They reported the parasite in Oregon and Washington.

Another parasitic copepod, *Achtheres ambloplitis*, was found on the gill arches and gill rakers of a number of black bullheads (*Ictalurus melas*) from Wall Lake, Minnehaha County, and Lake Hendricks, Brookings County, South Dakota. Apparently, this is the first report of *A. ambloplitis* from bullheads. The species is very similar to *A. pimelodi*, a form recorded from bullheads and catfish. Appreciation is extended to Mr. T. E. Bowman for identification of the South Dakota specimens. He mentioned the possibility that further taxonomic study might establish *A. ambloplitis* as a small form of *A. pimelodi*, thus making the former a synonym of the latter.

60. **Zoogeography of Sea Herring Parasites.** CARL J. SINDERMANN, U. S. Bureau of Commercial Fisheries.

Probably no other marine teleost has been scrutinized more closely from the viewpoint of parasites and diseases than the Atlantic sea herring, *Clupea harengus*. Recent attention has been directed toward the distribution of parasites of this species in the Western North Atlantic (Sinderman, Maine Dept. Sea & Shore Fish. Res. Bull. No. 27, pp 1–30, 1957). This and subsequent work has disclosed the presence of discontinuities and variations in parasite abundance that have provided insights about populations and movements of the fish hosts. Certain parasites thus constitute "natural marks" or tags.

Considering the western North Atlantic area from Newfoundland to the New Jersey coast, a fungus (*Ichthyosporidium hoferi*) is at present a common parasite of Gulf of St. Lawrence herring, but is extremely rare in the Gulf of Maine. Conversely, a cestode larva (Trypanorhyncha) is abundant in fish from the southern Gulf of Maine but is entirely absent from the Gulf of St. Lawrence. Larval nematodes (Anisakinae) reach a peak of abundance in herring from Newfoundland and the Nova Scotia coast, but decrease sharply in the Gulf of Maine and the Gulf of St. Lawrence. Parasites of immature herring may also occur discontinuously. The myxosporidian *Kudoa clupeidae* is common in one- and two-year-old herring from the southern Gulf of Maine and Gulf of St. Lawrence, but is absent in northern regions of both gulfs. Temperature appears to play a role in the distribution of this protozoan parasite.

That certain herring parasites vary in abundance periodically has been demonstrated in the case of the fungus. Epizootic peaks of this disease have been a matter of record for more than half a century, with periods from 15 to 20 years. Other parasites, notably the larval worms, have been found to vary in abundance only slightly from year to year in any particular area.

Sea herring occur across the North Atlantic from Virginia to Greenland, and from Iceland to the White Sea, so the larger picture of parasite distribution is still to be elucidated. Dollfus (J. Cons. **22**: 58–65, 1956) has assembled a list of European herring parasites, which includes many species never recorded from the western North Atlantic. Since herring provide the basis for one of the world's greatest fisheries, future international cooperation in the study of their parasites may well provide greater understanding of broad-scale migration and racial problems.

61. **A Study of the Parasitism of the Deer Mouse, *Peromyscus maniculatus*, in the Bonneville Basin of Utah and Its Role in Parasite Distribution.** ALBERT W. GRUNDMANN AND JOHN C. FRANDSEN, Department of Zoology, University of Utah.

The parasitism of *Peromyscus maniculatus* was investigated as a phase of a study of parasitism in isolated rodent populations in a 20,000-square-mile area of the Bonneville Basin. Deer mice form a continuous interbreeding population over the entire area, and with the exception of the barren salt flats, range from the desert floor to above timberline in the isolated mountain ranges bordering the basin. This almost universal distribution allows the deer mouse to become a distributing agent of its parasitic species to populations of other susceptible rodent species occupying restricted and isolated parts of its range. To interpret the parasite distribution in isolated rodent populations one must be familiar with the parasites of wide ranging and overlapping species.

Specimens were collected from the Great Salt Lake Desert and localities in the Wasatch, Raft River, Deep Creek, Cedar, Stansbury, Onaqui and Oquirrh mountains. Parasitic species recovered, except for 2 collected once each, appeared to be quite uniformly distributed over the area regardless of elevation and ecology, and also appeared to be present in other rodent species in the area. The following were recovered: Nematoda, *Syphacia peromycsi, Protospirura numidica,* and *Rictularia coloradensis;* adult Cestoda, *Catenotaenia linsdalei* and *Hymenolepis citelli;* larval Cestoda, *Mesocestoides carnivoricolus, Paruterina candelabraria* and *Cladotaenia circi;* Acanthocephala, *Moniliformis clarki;* Trematoda: *Brachylaima* sp. *Cladotaenia* and *Brachylaima* were collected but once and are new records. It is considered that no reliable conclusions concerning parasitism of isolated populations are possible without data on associated wide-ranging species such as the deer mouse.

(This work has been supported by a grant from the National Science Foundation.)

62. **Digenetic Trematodes of Marine Fishes from the Carribbean Sea Adjacent to Puerto Rico and Mona Island.** A. H. Siddiqi and R. M. Cable, Purdue University.

Examination of about 800 marine fishes representing over 150 species yielded approximately 126 species of digenetic trematodes of which about 43 have not been reported from other localities and include 8 new genera. Comparison of trematodes from waters adjacent to Puerto Rico and Mona Island, about 45 miles apart, indicates that deep water and ocean currents between relatively close land masses may serve as barriers to the movement of shallow-water fishes and hence provide an isolating mechanism leading to independent speciation of their trematode parasites. Although the study included but 15 species of fishes from Mona Island waters and 12 of those were examined in equal or usually larger numbers in Puerto Rico, 9 new species were found at Mona with but one occurring also in Puerto Rico where 34 additional new species were found. The numbers of new species found in the two localities are roughly proportional to the numbers of host species that harbored trematodes and suggest that had more fishes been examined at Mona Island, several additional new species would have been found.

(Supported by a Grant from the National Science Foundation, Contract No. G-6125.)

63. **Observations on the Development of Ascaridoid Nematodes of the Carpet Snake.** J. F. A. Sprent.

Three species, belonging to the genera *Amplicaecum, Ophidascaris,* and *Polydelphis,* respectively, have been studied. Experimental infection of mice with embryonated eggs has revealed 3 distinct patterns of migratory behaviour. *Amplicaecum* larvae, erroneosuly regarded by the writer (Sprent, J. F. A., 1953, *J. Parasit.* **39** (supp) p 38) as *Ophidascaris* larvae, remained in the liver and grew to a maximum length of 10.9 mm at 3 weeks after infection. *Ophidascaris* larvae were encapsulated in the subcutaneous tissues, growing to a length of 1.8 mm. *Polydelphis* larvae mostly remained in the intestinal wall, growing to a length of 2.1 mm. Third-stage *Amplicaecum* larvae, structurally similar, but in most instances considerably larger than those in experimentally infected mice, were found in the viscera of a number of wild animals in Queensland: in rats (*Rattus rattus, R. assimilis, Melomys cervinipes, Uromys caudimaculatus* and *Hydromy chrysogaster*); in a bat (*Rhinolophus* sp.); in bandicoots (*Parameles nasuta* and *Thylacis obesula*), and in a phascogale (*Phascogale tapoatafa*). These larvae were of various sizes, but some measured over 100 mm. Experimental infection, through feeding embryonated eggs of *Amplicaecum,* was obtained in *R. assimilis, R. rattus, R. norvegicus, M. cervinipes,* guinea pigs and handicoots, but not in the dog and cat. It is probable that these, and various other native animals of Queensland, act as natural intermediate hosts for *Amplicaecum.* It seems possible that a primary intermediate host may also be involved, as the most frequently infected animals are insectivorous.

Amplicaecum larvae moulted for the first time in the egg at 0.3–0.5 mm. In experimental infections in mice, they migrated to the liver as second-stage larvae. At 5 days after infection the second moult occurred at a length of 0.5–0.7 mm. The third-stage larvae grew to a length of 40 mm in the liver and caused severe lesions. Fourth-stage larvae and adults were only observed in the carpet snake.

64. **Insects as Possible Paratenic Hosts of** *Ancyclostoma caninum.* MAURICE D. LITTLE, Tulane University.

Blatella germanica, Periplaneta americana, P. fuliginosa, and *Tenebrio molitor* were successfully infected with *Ancylostoma caninum* third-stage larvae by placing them on charcoal cultures of the larvae, by feeding them larvae in water, and by injecting the larvae into the body cavity and the rectum. In the infected insects, living larvae were found in the tracheae, muscles, lumen and wall of the mid-gut, body wall, and the Malpighian tubules, most frequently the latter. Tissue reaction around living larvae was observed in the hemocele, in the body wall, and on the outer surface of the mid-gut. Larvae free in the hemocele were found to be encapsulated within 1 or 2 days. After 34 days, all but a few of the encapsulated larvae in the hemocele were dead. On the other hand, living larvae were recovered from the Malpighian tubules after 80 days in *B. germanica* which was the limit of the observation. There was no apparent development or increase in size of the larvae in any of the insects. It was found that larvae could survive for at least 3 days on the external surfaces of cockroaches, and there were some indications that they may survive there for much longer periods. These observations suggest that insects may serve as paratenic hosts of *A. caninum* and thus serve as a natural source of infection, especially for cats. Attempts to find *A. caninum* larvae in wild-caught cockroaches have been unsuccessful thus far. In a limited survey of wild-caught cockroaches, only the larvae of *Gongylonema* were found.

65. **Observations on the Nature of the Cyst of** *Trichinella spiralis.* A. L. RITTERSON, University of Rochester School of Medicine and Dentistry.

Analysis of cysts of *Trichinella spiralis* may provide useful clues for the study of the biology of connective tissue. The cysts used in this study were recovered from golden hamsters which had been infected for 50–65 days. Intact, debris-free cysts were isolated from blendor-minced tissue, washed, and transferred individually to a hanging drop preparation of the appropriate test solution. Alternatively, larvae were removed and cyst walls were affixed to slides for study.

Crude collagenase was prepared from 72-hour cultures of *Clostridium histolyticum* by dialysis and subsequent lyophilization of the culture supernate. The enzyme was prepared as a 1 percent solution in phosphate buffer (pH 7.6) and assayed against hide powder and fresh hamster Achilles tendon.

After 4–6 minutes' exposure to collagenase (37° C), the cyst wall became swollen; its increasing plasticity was revealed by the lively motions of the contained larvae. Worms effected their escape within 15–25 minutes of exposure to the enzyme. Thereafter, the cyst wall was gradually digested. Digestion was usually complete in 1 to 1½ hours. Free larvae were unaffected by the enzyme for a period of at least 24 hours. Collagenase acted more slowly on heat-treated cysts. Buffer controls and heat-inactivated enzyme were not lytic for this structure. Trypsin, pancreatin and hyaluronidase were not active against native cysts. Clorox (1 percent sodium hypochlorite) caused a very rapid (1–3 min.) dissolution of the cyst wall.

Stained preparations of cyst walls revealed structural properties very similar to those described by Rich et al (Bull. Johns Hopkins Hosp. **92:** 222–243, 1953) for altered collagen isolated from Arthus reactions.

(This investigation was supported by a research grant (E-1042) from the National Microbiological Institute of the National Institutes of Health.)

66. **An Investigation of the Metabolism of the Nematode,** *Syngamus trachea* **(Montagu, 1811) Chapin, 1925.** R. F. KRUEGER, Michigan State University.

The metabolic activities of *Syngamus trachea,* aerobic oxygen consumption and carbon dioxide liberation, endogenous and exogenous carbohydrate utilization, butyric acid utilization, and anaerobic carbon dioxide liberation, were most pronounced in the youngest and smallest nematodes and gradually decreased as the weight increased.

Respiration studies were conducted by standard manometric techniques. The rate of oxygen utilization of paired *Syngamus* decreased from 18.54 to 4.08 microliters per mg. dried weight per hour as the worms aged and increased in weight. The rate of oxygen consumption was decreased by such inhibitors as azide, cyanide, 2, 4-dinitrophenol, fluoride, iodoacetate and malonate. Inhibition by fluoride and malonate took place only in a calcium free substrate. Oxygen utilization was also decreased following gassing with carbon monoxide, and was still further decreased when *Syngamus* was maintained in darkness. The respiratory quotient (RQ) in a phosphate buffered substrate with or without 0.005M glucose was 0.87, while in a substrate of 0.065M butyric acid the RQ was 0.708. An RQ near 1.0 was obtained with an acetone powder prepared from *Syngamus* and present in phosphate buffered substrate containing 0.005M glucose.

The rate of endogenous polysaccharide utilization of *Syngamus* was 0.35 percent of wet weight/24 hours. Exogenous glucose utilization decreased with increased size of the nematode from 3.89 to 0.23 mg./gm. wet weight/hour. There was a pronounced increase in the rate of exogenous glucose utilization when *Syngamus* was maintained in vitro for ten days.

67. **The Infectivity of *Strongyloides ratti* for Various Rodent Hosts.** G. WERTHEIM, The Hebrew University-Hadassah Medical School, Jerusalem, and The Johns Hopkins University.

Over 40 species of *Strongyloides* have been named, mainly on the basis of occurrence in different hosts or in different localities. The morphological characters reported do not enable a distinction between the parasitic females of these species. Thus, it seemed desirable to test the specificity of this parasite in a series of rodent species.

A strain of *Strongyloides* isolated from wild rats and tentatively determined as *S. ratti* was used for experimental infections. During the first 2 months after isolation the strain produced in albino rats an infection which lasted on the average about 100 days (judged from the presence of eggs and first-stage larvae in the feces); however, it later dropped to about 35 days. The prepatent period, from the inoculation with infective larvae to the appearance of eggs and larvae in the droppings, was 5 days.

Five species of rodents were used for experimental infections: *Acomys cahirinus, Microtus guentheri, Meriones tristrami,* the golden hamster and albino mice. The wild rodents were bred for several generations in the laboratory before being used in these experiments. All animals were infected by intraperitoneal injection. Preliminary experiments showed that these hosts can be arranged in an ascending series of susceptibility to the parasite.

A. cahirinus proved to be entirely refractory. Eight young (4–5 weeks) animals and 6 older ones were injected with varying numbers of infective larvae (250 to 2000), but none developed an infection. Attempts to infect percutaneously, as well as the use of splenectomized animals, gave negative results. Of 14 albino mice of various ages, 4 young ones (4 weeks old) developed transient infections that lasted for 2 days. In *M. guentheri* the infection persisted for 60 days (as compared with 30 days in control laboratory rats), but the number of adults, and consequently, the number of eggs produced, was greatly reduced. (The number of eggs produced by a single female seems to be lower in this host but additional experiments have to be performed to prove this point). *M. tristrami* and the golden hamster proved to be hosts in which the infection persisted much longer than in the control rats, the maximum duration in these experimental hosts being 170 and 143 days, respectively. In the hamsters the prepatent period was 5 days and in *M. tristrami* 5 to 7 days. The number of eggs and larvae produced in *Meriones* proved to be higher than the control rats (as calculated from counts taken daily from a weighed amount of feces).

The possible influence of various hosts on the morphology of the parasite is being investigated.

68. **The Effect of Cortisone on Natural Resistance and Acquired Responses of the White Rat to Infection with *Litomosoides carinii*.** NORMAN T. BRIGGS, University of Texas Medical Branch.

Previous work has shown that the mature white rat exhibits a virtually absolute resistance to infection with *Litomosoides carinii,* and that following the introduction of infective larvae into this abnormal host the latter develops antibodies demonstrable by the formation of precipitates at the oral openings of larvae cultured in specific antiserum. The present work is concerned with attempts to modify these responses by the daily administration of cortisone (30 to 50 mg/kg) beginning either on the day of infection or 6–10 days before infection.

All cortisone schedules were associated with a depression of resistance of the abnormal host as evidenced by the recovery of 25-day-old worms in numbers approximating those expected for the normal host, the cotton rat. Evidence of a residual resistance in such white rats, however, was shown by the fact that most of the worms recovered were stunted in growth and development. Serum from rats pretreated with cortisone showed a lack of in vitro reactivity. On the other hand, such reactivity was noted in serum from donors receiving cortisone for the first time on the day of infection.

69. **Immunity Produced by Two Strains of *Litomosoides carinii* in Gerbils and Cotton Rats.** J. ALLEN SCOTT AND JOHN H. CROSS, JR., University of Texas Medical Branch at Galveston.

We have previously reported that a rice rat strain of *L. carinii* does not readily infect cotton rats, but that both this strain and the cotton rat strain develop well in Mongolian gerbils.

In the present experiments gerbils and cotton rats were given 2 immunizing infections of either the cotton rat strain or the rice rat strain. In cotton rats only a few worms of the rice rat strain developed, but the percentage development of both strains in the gerbil was as high as that of the cotton rat strain in cotton rats. Worms of challenging infections with the cotton rat strain superimposed on the immunizing infections of either strain were retarded in growth and development in both hosts. It is of especial interest that the rice rat strain produced this immunizing effect in cotton rats even though very few worms of the immunizing infections had developed. In all cases the worms of the challenging infections grew more rapidly in gerbils than in cotton rats.

(This work has been supported in part by Research Grant E 64 from the National Institutes of Health and by Research grant G 4088 from the National Science Foundation.)

70. **Free Amino Acid Content of the Blood of Natural and Experimental Hosts of the Filarial Worm** *Litomosoides carinii.* E. AHMED ZEIN-ELDIN AND J. ALLEN SCOTT, The University of Texas Medical Branch at Galveston.

In the study of resistance to *Litomosoides carinii* infections, the free amino acid pattern has been determined for the whole blood of the natural hosts, the cotton rats *Sigmodon hispidus texianus* and *S. hispidus hispidus,* a substitute host the gerbil *Meriones unguiculatus,* and two resistant hosts, the white rat *Rattus rattus* and the rice rat *Oryzomys palustris natator.* Blood proteins were precipitated and the supernatant desalted and concentrated. The amino acids in the concentrate were separated on two-dimensional chromatograms using phenol and 2,6-Lutidine as solvents and 0.2 percent ninhydrin in acetone for development. The maximum density of each spot was measured on a densitometer. The two subspecies of cotton rats gave identical patterns. Their free amino acids arranged in the order of decreasing concentration are: glycine, serine, alanine, leucine-isoleucine, glutamine, glutamic acid, valine, unknown 2, lysine, threonine, unknown 1, tyrosine, and gamma aminobutyric acid. In the same order the gerbil pattern is: lysine, unknown 3, alanine, leucine-isoleucine, glutamine, glycine, taurine, unknown 4, threonine, tyrosine, and valine. The white rat pattern is: lysine, glysine, alanine, taurine, unknown 3, arginine, leucine-isoleucine, unknown 5, threonine, valine, glutamine, gamma aminobutyric acid, tyrosine, and unknown 4. In the rice rat the pattern is: lysine, glycine, alanine, taurine, unknown 3, arginine, leucine-isoleucine, valine, glutamine, threonine, gamma aminobutyric acid, and tyrosine. Both qualitatively and quantitatively the amino acid patterns of the resistant hosts the white rat and the rice rat are nearly identical, but the cotton rat and gerbil differ from these and from each other.

(Supported by the J. W. McLaughlin Foundation.)

71. **Vital Staining and Differentiation of Microfilariae.** NATHANIEL ROTHSTEIN, MARCUS L. BROWN, AND ROBERT W. CARITHERS, Walter Reed Army Institute of Research.

A method will be described in which vital staining of microfilariae with Acridine Orange has provided means for a rapid scanning of whole blood suspensions to detect the viable microfilariae with the aid of dark ground illumination and the ancillary use of glass color filters. Differentiation of viable microfilariae of *Dirofilaria immitis, D. uniformis,* and *Dipetalonema* sp. has been accomplished with the closely related dye, Coriphosphine O. This has demonstrated, for the first time, cytochemical differences among these microfilariae which may imply physiological differentiation. Fourteen surveys, with a total of 724 dogs from Alabama, Pennsylvania and Rhode Island have been completed and the findings will be discussed. The vital staining technique has been compared with the modified Knott method and has been found to be at least as dependable, but more rapid, as a diagnostic technique. Other advantages of this technique are the added features of permitting one to study mobility characteristics, reactions to such external factors as dyes, and allowing the investigator to study host-parasite relationships.

72. **Studies on the Pseudocoelomic Fluid of the Nematode,** *Syngamus trachea* **(Montagu, 1811) Chapin, 1925.** R. F. KRUEGER, Michigan State University.

The character of the red pseudocoelomic fluid of the gapeworm, *Syngamus trachea,* was studied spectrophotometrically under various physical and chemical conditions and compared with turkey hemoglobin. The pseudocollomic fluid appears to contain an iron porphyrin compound which is probably a hemoglobin but not identical with that of the host's hemoglobin.

73. **Helminth-Parasites of the Camel,** *Camelus dromedarius,* **in the Sudan.** EMILE ABDEL MALEK, University of Khartoum.

Seventeen camels from the central Sudan were examined for their helminth-parasites, with the following results: *Avitellina woodlandi* (small intestine) 70.5 percent; *Trichuris globulosa*

(colon and caecum), 70.5 percent; *Echinococcus granulosus cysts* (lungs, liver, spleen), 52.9 percent; *Haemonchus longistipes* (4th stomach), 23.5 percent; *Impalaia* sp. (small intestine), 23.5 percent; *Oesophagostomum venulosum* (colon), 11.7 percent; *Schistosoma bovis* (mesenteric veins), 11.7 percent; *Moniezia expansa* (small intestine), 5.9 percent; *Nematodirus* sp. (small intestine), 5.9 percent; *Dictyocaulus viviparus* (bronchi), 0 percent; and *Fasciola gigantica,* 0 percent.

Further surveys might prove the existence of *D. viviparus* in Sudanese camels, as it occurs in Egypt in camels imported from the Sudan. It is possible that *F. gigantica* is found occasionally in the camel in areas where fascioliasis is common in cattle and sheep.

Haemonchosis in camels is believed to be the cause of death in some parts of the country, especially in cases of heavy infections.

Camel hydatid cysts, which are usually improperly disposed of, have no doubt been partly responsible for the spread of echinococcosis in dogs and, consequently, of a high incidence of hydatid cysts recorded in man in certain parts of the Sudan.

74. **Spirocercosis in Khartoum Dogs.** EMILE ABDEL MALEK, University of Khartoum, Sudan.

Of 24 dogs, both stray and pets, examined, 11 or 45.8 percent were found infected with *Spirocerca lupi.* Adult worms occurred in tumours in the walls of the esophagus, stomach and the thoracic portion of the aorta. Two cases were fatal aortic spirocercosis, with hemorrhage, pleurisy and toxemia on post mortem. The vessel wall was ruptured. Partial obstruction of the esophagus owing to the presence of large nodules was observed in some cases.

The abundance of the intermediate hosts, in the form of insects, mainly beetles, of various transport hosts and a reservoir host, the fox, is an important factor causing the spread of the disease. Four foxes were examined in Khartoum and Kosti, and all harbored this spiruroid and had large aortal nodules. Reports from veterinarians in various parts of the country indicate the high incidence of the disease in dogs.

75. **Another Unusual Case of Erratic Hirudiniasis.** MARVIN C. MEYER, University of Maine.

Among the leeches submitted recently for determination was a lot coming from an unusual and apparently unrecorded location, which is of especial interest and warrants reporting. This material, 2 specimens received August 12, 1958, through the Animal Disease and Parasite Research Division, U.S.D.A., was contributed by Dr. Birch L. McMurray, Florida Livestock Board, Callahan, and was accompanied by a note stating that the leeches were milked from the teats of a dairy cow. These leeches, as well as a second lot from Florida received about the same time, were identified as *Macrobdella ditetra* Moore, (1953, Notulae Naturae Acad. Nat. Sci. Phila., No. 250, 13 pp.). This recently described Hirudidae species, known from Texas through the Gulf States and the coastal plain north into North Carolina, replaces in this region the well-known *M. decora* (Say) of the northern United States and southern Canada. The specimens were approximately the same size, the larger measuring 60 mm long by 5 mm in greatest diameter, which agrees closely with the dimensions given by Moore.

The leech's predilection for secluded crannies, probably correlated with their search of the softer tissues as favorable feeding sites, is responsible for their being found in such unusual locations as the outer portals of the different body systems (nasopharynx, anus, external auditory canal, urogenital sinus of both sexes) of man and other animals. Due to their remarkable ability to distend, being unrivaled except by octopi, leeches can enter ducts of almost unbelievably small diameter.

76. **The Occurrence of *Eimeria tamiasciuri* in New Hampshire.** W. L. BULLOCK, University of New Hampshire.

Eimeria tamiasciuri Levine, Ivens and Kruidenier, 1957, was described from a red squirrel trapped on the north run of Grand Canyon in Arizona. At that time *E. tamiasciura* was recognized as the first coccidium to be found in the genus *Tamiasciurus.*

Two red squirrels, *Tamiasciurus hudsonicus loquax,* apparently killed by cars, have recently been found to be heavily infected with a coccidium. The first was obtained in March, 1959, in Newington, N. H.; the second was from Durham, N. H., in April, 1959. Sporulation of the oocysts in 2.5 percent potassium bichromate indicated that these coccidia were *Eimeria tamiasciuri.* These records from the red squirrel extend the range of the parasite by more than 2,000 miles.

Oocysts of the parasite were found throughout the digestive tract from the anterior duodenum through the rectum. Considerable numbers were present in the cecum. The middle third of the

small intestine appeared somewhat swollen and decidedly inflamed. Unfortunately, the animals were not considered fresh enough to make histological sections so it is by no means certain that this hyperemia was directly attributable to the coccidia.

77. **A Study of the Parasites of the Yellow Fin Tuna, *Thunnus catalinae*, Collected from the Gulf of Mexico in the Sacramento Shoals Area.** J. W. WARD, University of Mississippi Medical Center and Gulf Coast Research Laboratory, Jackson, Mississippi. (No Abstract Received.)

78. **The Occurrence of *Diphyllobothrium stemmacephalum* Cobbold, 1858, from the Dolphin, *Tursiops truncatus*, of the Biloxi, Mississippi, Bay.** J. W. WARD, University of Mississippi Medical Center, and the Gulf Coast Research Laboratory, and R. A. COLLINS, the Gulf Coast Research Laboratory.

One of us (R.A.C.) recovered at autopsy, 3 specimens of the tapeworm, *Diphyllobothrium stemmacephalum*, Cobbold, 1858, from the porpoise, *Tursiops truncatus*. The host died in the Marine Life aquarium at Gulfport, Mississippi. The natural habitat of the host was the Biloxi Bay, Mississippi.

The average length of the 3 specimens was 13 meters, with more than 3,000 segments per specimen. Unfortunately, no scoleces were recovered. The average dimensions of immature segments, 5 mm by 0.6 mm; mature segments, 26 mm by 5 mm; gravid segments, 19 mm by 4 mm; longitudinal muscle zone more than twice as thick as transverse muscle zone; cirrus pouch 325 micra to 375 micra by 160 micra to 260 micra; 6 to 9 uterine loops on each side; eggs, 66 micra to 72 micra by 42 to 52 micra.

The identification of this tapeworm was confirmed by Dr. James A. McLeod of the University of Manitoba.

79. **The Effect of Experimental Infections of the Coccidium *Eimeria faurei* on Wool.** JOHN C. LOTZE, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md.

In a study on the pathogenicity of a pure strain of the coccidium *Eimeria faurei* in 3-month-old lambs which had been raised parasite-free, coccidial infections produced with single inoculations of 1, 5, 10, or 50 million sporulated oocysts caused wool-breaking which took place in a period of 7 to 11 days commencing 42 to 44 days after inoculation; there was no evidence of wool-breaking in another lamb which had been inoculated with 20 million sporulated oocysts. The wool-breaking was most extensive in the lambs which had been inoculated with either 1 or 50 million oocysts, and least extensive in the one which had been inoculated with 10 million oocysts. The extensiveness of wool-breaking was correlated with interference with metabolism as indicated by weight trends beginning on the 5th or 6th day after inoculation; wool-breaking was greatest in cases where the decrease in weight was greatest. At the time of the wool-breaking, the parasites either were absent from the feces or were so few in number that it is unlikely that they would have aroused suspicion of their being the cause of the damage. These observations bring to the attention the necessity of considering the coccidia along with helminth parasites as possible causes of inferior wool fibers.

80. **A Bacterial Disease of *Ascaris suum*.** T. B. STEWART, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, AND H. J. GODWIN, Georgia Coastal Plain Experimental Station, Tifton, Georgia.

On several occasions yellow-brown spots have been observed on the cuticle of *Ascaris suum* recovered from hogs at Tifton, Georgia. Sometimes these lesions were present in such numbers as to give the appearance of "polka dots." Microscopic examination of these lesions revealed that they were craterlike, were raised peripherally and depressed centrally, and involved necrosis and erosion as well as thickening of the cuticle. Since there had been a few reports in the literature of the isolation of bacterial organisms from *A. suum*, in one of which Manter (1929, J. Parasit. **16**: 101) described cuticular lesions which were associated with an organism resembling *Clostridium welchii*, an attempt was made to discover the cause of the lesions observed. These experiments resulted in the isolation of three microorganisms, *Escherichia coli*, *Candida* sp., and a pseudomonas-like bacillus. Living specimens of *A. suum* having no lesions on the cuticle were exposed to cultures of each of these organisms in vitro. The worms exposed to the pseudomonas-like bacillus developed white spots the size of a pinhead, white ring-like lesions, and large yellow-brown circumscribed spots. The three types of lesions appeared to correspond to different stages of thes same disease process. The worms exposed to cultures of *E. coli* and to *Candida* sp. did not develop lesions.

The organism that produced the lesions observed by us was identified by S. F. Sniesko, Fish and Wildlife Service, U. S. Department of Interior, as a *Pseudomonas* that was not typical of any of the well-described members of the genus. It, therefore, does not appear to be identical with any of the previously reported organisms recovered from specimens of *A. suum.*

81. **Survival of *Histomonas meleagridis* and Eggs of Five Species of Turkey Nematodes Outdoors on Soil.** MARION M. FARR, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md.

Two different series of tests have been conducted to determine how long the blackhead organism, *Histomonas meleagridis,* and eggs of certain nematodes of turkeys remain viable when exposed to outside weather conditions at Beltsville, Maryland. Droppings collected from infected chickens and turkeys were distributed on soil in small outdoor plots. From time to time samples of this fecal material and the soil were collected from the plots and fed to isolated turkey poults. Fourteen to 30 days after the feeding of the material, the poults were killed and examined for evidence of histomoniasis and nematodes. It was found that *Heterakis gallinae* eggs remained infective up to 230 weeks, *Ascaridia* spp. (either *A. dissimilis* or *A. galli* and perhaps both) eggs up to 161 weeks, *Capillaria obsignata* eggs up to 102 weeks, and *Syngamus trachea* eggs up to 31 weeks. *Histomonas meleagridis* was infective as late as the 151st week. Since the unprotected blackhead organism dies within a few hours outside the avian host, it must be assumed that *Histomonas* is incorporated within the *Heterakis* egg.

82. **The Incidence of Swine Lungworm in Nebraska.** GEORGE W. KELLEY AND H. G SEN, University of Nebraska.

Metastrongylus spp. impair swine production by injuring lung tissue, enhancing respiratory infections (Underdahl, 1958 unpub.) and serving as vectors of virus diseases (Shope, 1958). Spindler (1934) found lungworm in 69 percent of 368 pigs from Southeast U. S. Hawkins (Morgan & Hawkins, 1949) reported on incidence of 31 percent in 1000 Michigan hogs and Goldsby and Todd (1957) found 66 percent of 101 Wisconsin pigs infected. In 1953 Sullivan and Shaw found lungworms in 52 percent of 518 pigs from the Willamette valley of Oregon. The extent of swine lungworm infection in cornbelt herds has not been established hence the observations reported herein. Almost all of the hogs came from farms within 200 miles of the Hormel Packing Plant at Fremont, Nebraska, where this study was done.

Six monthly samples of 100 lungs were examined. Each sample was selected by examining every fifth animal on the line until 100 had been observed. The diaphragmic lobe of the lung was excised 1 inch from the distal end. The excised portion was compressed to express lungworms, which may have been present. This technique revealed the majority of the infections, but doubtlessly some were overlooked.

Six monthly observations produced an average incidence of 23 percent infection with swine lungworms, *M. apri* or *M. pudendotectus.* There was no marked difference between months: November, 22 percent incidence; December, 26; January, 34; February, 20; March, 25; and April, 11.

83. **Possible Significance of the Retention of Immature Larvae of *Oesophagostomum quadrispinulatum* (*O. longicaudum*) in the Intestinal Mucosa of Swine After Single Infections.** DOYS A. SHORB AND WILLIAM T. SHALKOP, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

Single doses of 150,000 to 209,000 infective larvae of *Oesophagostomum quadrispinulatum* were administered to 26 worm-free pigs, 42 to 70 days old, weighing 17 to 50 pounds. These pigs were killed from 1 to 65 days after infection, and the nodular worm populations of the lumen of the large intestine and of the intestinal mucosa were estimated. The nematodes in the mucosa were extracted by artificial digestion. Before digestion, portions of the large intestine were fixed for later histological study. In addition to the worms that developed normally, third-stage larvae were recovered from the mucosa of 20 pigs killed from the sixth to the sixty-fifth day, and fourth-stage larvae from 11 pigs killed from the tenth to the sixty-fifth day after infection. Of particular interest was the recovery of 2,240 third-stage larvae, 120 fourth-stage larvae, and 3,220 sexually mature adults from the pig killed 51 days after infection and of 997 third-stage larvae, 407 fourth-stage larvae, and 2,940 mature adult worms from the pig killed 65 days after infection. Although none of the larvae were alive after exposure to the digestive fluid, there was no histological evidence that they were dead prior to the twenty-seventh day after infection. There was, however, evidence of sufficient tissue reaction surrounding them to prevent their escape from the mucosa. Other workers have advanced two hypotheses to account for the retention of such larvae in the host's tissues: (1) that the development of the retained

larvae is only temporarily retarded and that under suitable conditions they will eventually break out and continue their development; and (2) that the larvae are overwhelmed by the host's defenses and will eventually die. Since histological evidence indicates that the larvae in the mucosa of the pigs killed 51 and 65 days were dead, the writers consider that their findings support the last-mentioned hypothesis.

84. **Blood and Plasma Volume, Total Serum Protein, and Electrophoretic Serum Fractination of Sheep Experimentally Infected with** *Trichostrongylus axei.* S. E. LELAND, JR., J. H. DRUDGE, AND Z. N. WYANT, Kentucky Agricultural Experiment Station, Lexington.

Eighteen animals (Cheviot ram crossed with grade western ewe) 159 to 657 days old at the time of infection were used in the study. Pre- and post-infection measurements as well as parallel measurements on uninfected control animals were made over a 4-month period. The range of single doses of larvae was 50,000 to 1,500,000. All animals were maintained from birth through the experimental period under conditions where unintentional acquisition of helminths was eliminated.

Serum protein alterations were (1) hypoproteinemia as evidenced in grams per 100 ml and total grams of circulating protein, and (2) a hypoalbuminemia with an increase in gamma globulin.

The sequence of events with respect to blood and plasma volume alterations in infected animals was the development of polycythemic hypovolemia which, if the animal survived, developed into an oligocythemic hypovolemia.

85. **Studies on the Serological and Immunological Responses of Calves Artificially Infected with the Stomach Hairworm,** *Trichostrongylus axei.* HARRY HERLICH AND RICHARD S. MERKAL, Regional Animal Disease Research Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Auburn, Alabama.

Calves were artificially infected with the stomach hairworm, *Trichostrongylus axei,* by administration of (1) single and multiple doses of infective larvae, and single doses of (2) fourth-stage, fifth-stage, and sexually-mature worms, and (3) sexually-mature worms only. Such infections stimulated the production of circulating antibodies as detected by hemagglutination tests. Adult *Haemonchus contortus* recovered from sheep were used as a source of antigen. Titers as high as 1 in 1,280 were noted, the highest titers being manifest in the calves infected by administration of infective larvae. However, on the basis of fecal egg counts and postmortem worm recoveries, the serological responses were not accompanied by any evidence of active immunity.

Artificially exsheathed *T. axei* infective larvae were incubated in (1) saline, (2) serum from these artificially infected calves, and (3) serum from helminth-free calves. Larvae remained viable in all media for 72 to 96 hours, and no larval precipitates were observed. Exsheathed *T. axei* larvae also appeared to be unaffected when incubated in serum from a calf having a natural heavy infection with several species of gastrointestinal nematodes including *T. axei.* They were likewise unaffected when incubated in serum from another calf that was artificially infected by oral administration of 554,000 *T. axei* infective larvae in 4 doses over a 5-month period, although, after each of the last 3 doses, larvae and adult worms were expelled with the feces of this calf.

86. **Experimental Studies on the Relationship of** *Ostertagia circumcincta* **to Parasitic Gastritis in Sheep and Goats.** K. C. KATES, G. I. WILSON, AND J. H. TURNER, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

A number of experimental studies on ostertagiasis of sheep, as well as the occurrence of massive natural infections of *Ostertagia* spp. in this host, have been reported previously by various workers. However, the true significance of these parasites as pathogens in sheep and goats needs further clarification.

Our experiments completed to date involved parasite-free lambs experimentally infected with *O. circumcincta* by administration of single doses of 25,000, 50,000, 100,000, 150,000, and 200,000 and of weekly doses of 25,000 for a total of 225,000 infective larvae to each of 2 lambs for each dosage rate. Also, pairs of parasite-free kids were likewise infected with single doses of 100,000 and 200,000 and similar multiple doses of infective larvae. These infections were under observation for several months. Additional parasite-free lambs were given single doses of 100,000 larvae each and were killed at intervals during the prepatent period for the purpose of checking the degree of initial infection and to restudy the histotrophic phase of the parasite in the abomasum.

Lambs killed during the prepatent period had substantial infections, as well as typical gross and microscopic lesions previously reported by other workers; typical and unusual abomasal lesions will be illustrated. No obvious clinical symptoms were associated with the infections, and significant departures from normal weight gains were noted only in two pairs of infected kids given the largest numbers of larvae. If these results are substantiated by further work, it may be concluded that this parasite has a lower pathogenic potential than other abomasal nematodes of sheep and goats.

87. **Further Observations on the Life History and Development of *Ascaridia columbae* (Gmelin, 1790) Travassos, 1913, in the Pigeon.** EVERETT E. WEHR AND JOSEPH C. HWANG. Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville Maryland.

Hwang and Wehr (1958, J. Parasit. **44** (4-Sect. 2) : 26) reported the results of some preliminary studies on the migration of the larvae of *Ascaridia columbae* in the body of the pigeon. In the present paper the results of further studies on the life cycle of this parasite within the avian host, as well as observations on the developing embryos, are reported.

When the eggs were cultured at room temperature, the embryos developed into infective second-stage larvae within 2 to 3 weeks. Approximately 5,000 embryonated eggs were administered *per os* to each of 40 pigeons, which were then sacrificed from 6 to 1,176 hours after infection The recovery of developing larvae from the internal organs was carried out in the same manner as described previously.

Second-stage larvae were recovered from the lumen of the intestine 6 hours after the administration of the embryonated eggs. Sixteen hours after ingestion a few second-stage larvae were recovered from the liver. Specimens and exsheathed third-stage larvae were observed in this organ as early as the sixth day after infection. Larvae were recovered from the liver in varying numbers for at least 21 days. Third-stage larvae were recovered from the lungs on the sixth, seventh, and tenth days after infection. Fourth-stage larvae were recovered from the intestine about the fifteenth day after the eggs were ingested. It was estimated that *A. columbae* attained egg-laying maturity 48 to 50 days after infection. The finding of the larvae in the lungs and the liver indicated that the life cycle of this parasite was similar to that of *Ascaris suum.*

88. **Factors Influencing the Distribution of *Heterakis* in the Ceca of Chickens and Turkeys.** EVERETT E. LUND, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

Two hundred and ninety-eight purebred New Hampshire Red chickens, 5 weeks old when given a single dose of 154 to 174 embryonated eggs of *Heterakis gallinae,* produced an average of 114 worms in their left ceca for each 100 in their right ceca. This ratio was approximated on all of 5 tests employing 60 birds each, involving a total of more than 47,000 embryonated eggs, and resulting in the recovery of almost 27,000 worms. These worms were recovered at necropsies, performed at uniformly designated intervals between 10 and 63 days after infection. Data from 2 birds that died at other intervals are not included. The distribution of worms along the linear axis of the cecum was studied and found to show a pattern which varied characteristically with the age of the worms.

The bilateral distribution was found to vary slightly with worms of different origins, but rather markedly with chickens of different breeds or considerably different ages. Multiple infections with *Heterakis* or continuous acquisition, as occurs on contaminated range, changed both the bilateral pattern and, obviously, the distribution along the linear axis. Any diseased condition of the cecum may greatly influence the pattern of distribution also.

Similar but not identical patterns of distribution of cecal worms were found in Beltsville Small White poults 6 to 8 weeks old at the time of infection.

Reasons for some of the patterns of distribution are postulated. Familiarity with these patterns is sometimes useful in tracing the source of infection of turkeys and chickens with blackhead.

89. **The Chronology of Experimental Intrauterine Infections with *Toxocara canis* (Werner, 1782) in the Dog.** JAMES R. DOUGLAS AND NORMAN F. BAKER, University of California, Davis.

Eight worm-free, cage reared bitches, 11 to 21 months of age, were given 20,000 infective *Toxocara canis* eggs at various times during pregnancy. Surgical removal and peptic digestion of fetuses at various intervals demonstrated that invasion of the fetus did not occur before the 42nd day of gestation. It was also found that *T. canis larvae* required at least 14 days following infection of the bitch to invade the tissues of the uterus and fetus. Five remaining bitches, kept free of exposure to *T. canis,* were bred again and whelped 241 to 358 days after the initial

infection. Fecal examination revealed that patent *T. canis* infections developed in every litter within 23 to 40 days of whelping and in every bitch within 25 to 46 days of whelping. These infections persisted in the bitches 9 to 108 days (ave. 60) and were aborted spontaneously.

90. **Immunity to *Cooperia punctata* and *Oesophagostomum radiatum* in Cattle.** Roy L. Mayhew, Louisiana State University.

Immunity has developed in 31 animals experimentally infected with *Cooperia punctata*. This is first indicated by a rapid drop in the egg counts to a very low level and often to 0. This is usually followed by an increase in the numbers of eggs to a lower level or in some to approximately the same as the preceeding range. The egg counts may remain at this low level or continue to be negative. Some individuals do not become definitely immune until a 3rd drop in egg counts occurs. Following the establishment of immunity, they remain negative or a very small number of eggs only are recovered. Twenty-seven animals have been reinoculated and they responded by remaining negative or with only a temporary usually very small increase in egg counts. Eleven of these animals that have been demonstrated immune to *Cooperia punctata* have been inoculated with infective larvae of the nodular worm (*Oesophagostomum radiatum*) and all have been shown to be susceptible to this species.

91. **A Comparison of Nematode Egg Counting Technics for Cattle and Sheep Feces.** Norman D. Levine, Krishna N. Mehra, David T. Clark and I. John Aves, College of Veterinary Medicine, University of Illinois, Urbana.

In a comparative study of fecal samples from 78 cattle and 13 sheep, the McMaster dilution technic was found to be far superior to the direct centrifugal flotation (DCF) technic for counting strongyle nematode eggs. In a series of 13 sheep, the egg counts obtained by the DCF technic with Sheather's sugar solution as the flotation fluid averaged 11 percent of those obtained by the McMaster technic. In a series of 15 cattle, the egg counts obtained by the DCF technic with Sheather's sugar solution averaged 22 percent of those obtained by the McMaster technic. In a second series of 24 cattle, the egg counts obtained by the DCF technic with 33.1 percent and saturated zinc sulfate solutions averaged 22 percent and 27 percent, respectively, of those obtained by the McMaster technic. In a third series of 26 cattle, the egg counts obtained by the DCF technic with Sheather's sugar and saturated sodium nitrate solutions averaged 46 percent and 36 percent, respectively, of those obtained by the McMaster technic. In a fourth series of 13 cattle, the egg counts obtained by the DCF technic with Sheather's sugar and saturated sodium nitrate solutions averaged 51 percent and 56 percent, respectively, of those obtained by the McMaster technic, while direct egg counts made by counting every egg in 0.1 g fecal samples averaged 92 percent of those obtained by the McMaster technic. The differences between the results obtained with different flotation solutions by the DCF technic were not significant at the 5 percent level, nor was the difference between the results obtaind by the McMaster and direct count technics. The differences between the results obtained by the McMaster and DCF technics were significant far beyond the 0.1 percent level.

92. **Studies on Parasitism of Feral Swine in Georgia.** Bert B. Babero, Department of Zoology, Fort Valley State College, Georgia, and Lars H. Karstad, Department of Veterinary Science and Bacteriology, University of Wisconsin, Madison.

Over a period of 2 years, 49 feral pigs from areas within the state of Georgia were observed to be parasitized by both ecto- and endoparasites. During the winter months *Haematopinus suis*, which heavily infested pigs, was the only ectoparasite found. In the summers, especially during the month of July, louse infestions of swine appeared to be less severe, but several kinds of ticks were found on animals, viz., *Dermacentor variabilis, Amblyomma maculatum* and *A. americanum*. The screw-worm, *Cochliomyia americana*, was observed infesting wounds.

Helminths from feral swine were recovered throughout the year. They were as follows: Nematoda: *Ascaris lumbricoides, Globocephalus urosubulatus, Hypostrongylus rubidus, Metastrongylus apri, Stephanurus dentatus, Strongyloides ransomi*, and *Trichuris suis;* Trematoda: unidentified microphallid; Acanthocephala: *Macracanthorhynchus hirudinaceus*. Although helminth parasites were invariably found in feral swine, the prevalence and number of species recovered were conspicuously low compared to those reported from domestic pigs of Georgia and Florida by Spindler in 1934. *Trichinella spiralis* was not found, despite the use of a pepsin-digestion technique. No cestodes were recovered from the viscera or the musculature. *M. apri* and *S. dentatus* were the most common endoparasites recovered. The pathology produced by these species appeared to be more serious than that caused by any other helminth. Unfavorable climatic conditions and malnutrition are undoubtedly important factors in predisposing feral pigs to parasitism. The natural conditions under which these animals live preclude any artificial means of controlling their parasites.

93. **Report on *Raillietina williamsi* in the Domestic Turkey.** W. MALCOLM REID AND DENIS NUGARA, University of Georgia, Athens.

A flock of 1400 domestic turkeys near Athens, Georgia, has been found to be heavily infected with a tapeworm which is being referred to the species *Raillietina williamsi* (Williams, 1931). The tapeworm corresponds in all but two characteristics to the description given by Williams (J. Parasit. **18:** 14–20, 1931). About 2 percent of the worms examined had irregularly alternating genital pores, while Williams described them as being unilateral. The specimens examined held 260 rostellar hooks rather than the 150 hooks reported by Williams.

There appears to be no previous report of this species from the domestic turkey. It seems probable that the source of infection was a group of some 8 wild turkeys brought in as mature birds from the State Game Commission Hatchery. Most of the scoleces were attached posterior to the yolk sac diverticulum. The intestines showed varying degrees of congestion in the area where worms were attached. The infection appeared to represent a definite flock problem since all but 2 out of some 150 birds examined contained from 1 to 175 worms each. Limited treatment studies showed 100 percent elimination in five birds given 65 milligrams per bird of dibutyl-tin-oxide by capsule, and 99 percent elimination in 9 birds at the level of 125 milligrams per bird. Eighty-five percent efficacy was found in 16 birds given 0.29 percent dibutyl-tin-dilaurate in the feed for 5 days. Fifty percent efficacy was found after 5 days feeding of Trithiadol® to 18 birds at 3 pounds per ton of feed.

94. **Spicular Anomalies in *Haemonchus contortus* That May Be Associated with Exposure to Phenothiazine.** WILLARD W. BECKLUND, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

During the examination of helminths recovered from sheep harboring moderate to heavy infections of gastrointestinal parasites, it was observed that 1 to 14 percent of the fifth-stage male *Haemonchus contortus* from 5 of 21 sheep had abnormally shaped spicules. The anomalous spicules were shorter and had more pronounced corrugations than those of normal males and lacked salient spurs and membranous expansions at their distal ends. In some specimens one spicule was as much as one-third shorter than the other. The gubernaculum was also shorter than in normal specimens. The 5 sheep from which the abnormal specimens were recovered and 4 others in which such specimens were not found had been treated therapeutically with phenothiazine between 1 and 3 weeks before necropsy. Similar abnormalities were not found among specimens recovered from 12 sheep not recently treated.

Since a causal relationship between exposure of these parasites to phenothiazine and the occurrence of these abnormalities in the adult spicules was suspected, specimens of *H. contortus* which were known not to have been exposed to phenothiazine were examined in order to ascertain the percentage of these populations that had similar anomalous spicules. Of 4,381 male *H. contortus* collected from 37 sheep and deposited in the United States National Museum Helminthological Collection from 1900 to 1939, only 1 male had similar aberrant spicules. Of 643 specimens collected from 1951 to 1958 from 4 sheep that were known never to have been therapeutically treated with phenothiazine, only 2 males had abnormal spicules.

These observations appear to support the hypothesis that the exposure of *H. contortus* to phenothiazine during its development may cause morphological changes in the spicules of the male. Such effects can cause a systematist considerable difficulty unless they are recognized as resulting from environmental factors.

95. **The Nematode *Cosmocercoides dukae* as a Parasite of the Slug.** R. E. OGREN, Dickinson College, Carlisle, Pennsylvania.

Nematodes are only occasionally encountered in gastropods. This paper describes an infestation of *Deroceras gracile* with *Cosmocercoides dukae* (Holl, 1928) Wilkie, 1930. Infested slugs were found in Wisconsin, Tennessee and several places in Illinois. The habitat was in the respiratory chamber of the mantle. Here were found adult males, ovoviviparous females, and rhabditiform and filariform larvae. The species may be able to multiply the infestation by using the mantle as a culture sac. The shell piece of the infested slugs was irregular and contained many large granular masses at the periphery. The normal shell did not have these granular masses. The life cycle is direct, since infective larvae enter the slug and mature. This species is a common parasite of the rectum of amphibians and reptiles. In gastropods it is most frequently found associated with the shell and mantle.

96. **Microelectrophoretic Studies of the Serum Proteins in Chickens Infected With Cecal Coccidiosis.** E. A. SCHLUETER, Michigan State University, East Lansing, Michigan.

The serum proteins of resistant, susceptible, and unselected chickens infected with *Eimeria*

tenella, causal agent of cecal coccidiosis, have been studied utilizing micro-electrophoretic techniques. The course of the infection has been followed serially in blood serum samples run electrophoretically and quantified photometrically. Comparisons have been made of the albumin and globulin levels and the A/G ratios. A drop in the relative albumin and globulin levels on the 5th day post-infection was noted in all of the animals studied. The albumin levels returned to normal gradually through the 7th and 9th days post-infection, but a significant rise in globulin levels above the normal was noted during the same period.

97. **Parasitologic Surveys in Cali, Departamento del Valle, Colombia.** VI. **Diagnostic Findings from Parasitologic Examination of Excreta of Dogs, Human Beings and a Hog Collected on the Streets of Ward Siloé, Cali, Colombia.** Luis E. Giraldo, Ernest Carroll Faust, Rafael Bonfante and Gladys Caicedo, Facultad de Medicina, Universidad del Valle, Cali, Colombia.

Freshly passed excreta, collected on the streets of ward Siloé, Cali, Colombia, were examined the same day for intestinal parasites, employing unstained and iodine-stained direct films and zinc sulfate centrifugal flotation technics. Of the 553 specimens studied, 528 were from dogs (D), 24 were human (M) and one was hog's feces (H). The following infections, expressed in percentage incidence, were diagnosed: PROTOZOA (cysts): *E. histolytica* 0.94 (D), 25.0 (M); *E. coli* 9.0 (D), 66.7 (M); *E. nana* 0.75 (D), 12.5 (M); *Iodamoeba bütschlii* 0.37 (D), 20.8 (M), 100.0 (H); *Giardia lamblia* 4.92 (D), 4.16 (M); *Balantidium coli* 0.37 (D); *Isospora hominis* 24.6 (D), 4.16 (M); *I. belli* 0.37 (D); *I. bigemina* var. *canis* 3.41 (D); *I. felis* 0.57 (D); *I. sp. (rivolta?)* 0.19 (D). HELMINTHS (eggs): *Enterobius vermicularis* 4.16 (M); *Ascaris lumbricoides* 24.24 (D), 50.0 (M), 100.0 (H); *Toxocara canis* 10.8 (D); *Trichocephalus sp.* 16.47 (D), 50.0 (M); *Ancylostoma* and *Necator* 71.2 (D), 37.5 (M); *Spirocerca lupi* 0.19 (D); *Hymenolepis diminuta* 0.37 (D); *Dipylidium caninum* 0.19 (D).

Negative: 16.47 (D), 4.16 (M). Although several of the diagnosed parasites from dogs' excreta were of canine origin, the evidence indicates that these wandering scavenger animals consume freshly deposited human feces and serve as mechanical vectors of human parasites, dispersing them from one locality to another in the ward under observation.

98. **Massive Infestation of Gastrointestinal Worm Parasites in a Farm-Raised Pig.** L. A. Spindler, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

This is to report an extraordinarily severe case of parasitism in a farm-raised pig. The case is considered noteworthy because of (a) the number of parasites involved and (b) the nature of the symptoms exhibited by the animal, which led to a tentative diagnosis of swine erysipelas. The most outstanding symptoms were purplish discoloration and peeling of the skin, loss of hair, movements stiff and to one side, coughing, and inappetence.

At autopsy, tests for erysipelas were negative, but a massive infestation of worm parasites was found. The numbers recovered are listed below.

Total, 9,812. Of these, 6,246 were ascarids, located as follows: Small intestine, 3,433; stomach, 2,272; large intestine, 141; lungs, 400. With the exception of 42 in the small intestine, all the ascarids were immature, 57% being less than 10 mm in length. In addition to ascarids, the pig harbored 35 thorn-headed worms in the small intestine, 2,274 thick stomach worms in the stomach, and 1,200 nodular worms and 57 whipworms in the large intestine and cecum combined.

The infestations were accompanied by (a) generalized inflammation of the gastrointestinal tract; (b) perforation of the intestinal wall at sites of attachment of the thorn-headed worms, with adhesions and strangulation of the intestine; (c) peritonitis; (d) petechial hemorrhages in the lungs, presumably caused by migrating ascarid larvae; and (e) small, whitish lesions on the liver, also ascribed to migrating ascarids.

Discoloration and peeling of the skin and disturbed locomotion are not ordinarily associated with gastrointestinal parasitism.

99. **Results of a Few Experiments Using Phenothiazine, Copper Sulphate and Nicotine Sulphate as Anthelmintics in Cattle.** Roy L. Mayhew and B. B. Lank, Louisiana State University.

Four animals infected with *Cooperia punctata* and *Bunostomum phlebotomum* were given phenothiazine at the rate of 10 grams per 100 lbs body weight. Twenty-two days later they were given 6 oz of a 2 percent solution of copper sulphate and 7 days later 6 oz of copper sulphate to which 1 percent nicotine sulphate was added. The level of egg counts remained the same throughout the period of observation.

One animal kept under controlled conditions and inoculated with *Cooperia punctata* was

given varying amounts of phenothiazine as follows: 10, 18, 30, 50 and 70 gm per hundred pounds of body weight. The larger amounts of 30 grams and above caused decreases in the egg count levels followed by gradual increases up to the former levels.

Two animals infected with the nodular worm under controlled conditions were given 10 gm of phenothiazine per 100 lbs of body weight. The egg count dropped to 0 the second day in both animals and remained so for 38 days in one and 71 days in the other. Following this, the number of eggs increased to 4 percent and 16.9 percent of the former levels. The data indicate that reinfection did not occur in the case of these animals, and that they remained a source of contamination about the premises of the owner.

100. **Cross-Transmission of *Haemonchus* from Pronghorn Antelope to Domestic Sheep, with Observations on the Pathologenicity of This Strain in Lambs as Compared with That of *Haemonchus* from Domestic Sheep.** R. W. ALLEN, K. S. SAMSON AND G. A. SCHAD, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, State College, New Mexico.

In 1958 (J. Parasit. **44** (supp.) : 26) the authors reported the cross-transmission of *Haemonchus* from the Bighorn and Barbary sheep to domestic sheep. In this paper the results of similar experiments are reported in which were used a strain of *Haemonchus* isolated from the pronghorn antelope (*Antilocapra americana*) which had been maintained in domestic lambs for 7 months and a strain from domestic sheep which had been maintained in these hosts for more than 4 years.

Eighteen worm-free lambs of comparable breeding, age, and sex were divided into three groups of six lambs each. The lambs of group 1 each received 14,000 infective larvae of the antelope strain, and those of group 2 received 14,000 infective larvae of the strain from the domestic sheep. The lambs in group 3 were not infected and were used as controls. The lambs were carefully observed for 73 days after administration of the *Haemonchus* larvae.

Three lambs in group 2 died. Death losses did not occur in the other two groups. The average daily gains of the lambs in groups 1, 2, and 3 during the period of observation were 0.324, 0.154, and 0.388 pound; the average quantities of feed consumed per day per lamb were 3.62, 3.24, and 3.90 pounds; the average hemoglobin levels were 10.24, 8.00, and 11.11 grams per 100 ml of blood; the average numbers of worm eggs per gram of feces were 1,863, 7,042, and 0; and the average numbers of *Haemonchus* recovered post mortem were 3,848, 7,541, and 0, respectively. These data show that under the conditions of the experiment the antelope strain was markedly less pathogenic to domestic lambs than was the strain from domestic sheep. These results were generally in agreement with those obtained with the strains from the wild sheep.

101. **Occurrence of *Capillaria obsignata* Madsen, 1945, in the Peafowl and Its Transmission to Chickens.** JOSEPH C. HWANG AND EVERETT E. WEHR, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

A peahen, *Pavo cristatus*, that had been raised in the backyard of a home near Lanham, Maryland, was submitted recently to the Beltsville Parasitological Laboratory for post-mortem examination. A large number of intestinal threadworms identified as *Capillaria obsignata* were recovered from this bird. So far as the writers are aware, this report constitutes the first record of this species from the peafowl. Since *C. obsignata* occurs commonly in the chicken, an attempt to infect this bird with the progeny of the worms recovered from the peahen was made. Gravid female *C. obsignata* from the peahen were placed in a petri dish containing 1 percent formalin solution, and were kept at room temperature until the eggs had become embryonated. The embryonated eggs were then administered per os to five 4-week-old chicks which had been raised worm free. Three similar chicks were kept as controls. Thirty-five days after the eggs were administered all the chicks were sacrificed. Several adult male and female *C. obsignata* were recovered from the small intestine of 3 of the 5 experimentally infected chicks; no worms were recovered from the controls. In addition, 6 worm-free young chicks were placed in the pen that had previously housed the peahen. One died 89 days later, and over 50 adult male and female *C. obsignata* worms were recovered from it. As the above pen had housed, prior to housing the peahen, chickens and pigeons, the source of the infection in this chick is not known. Four 4-week-old, worm-free chicks that were penned with pigeons infected with *C. obsignata* were found on necropsy 173 days later to harbor this parasite; 13 others were found to be negative. The present observations indicate that chickens can be infected experimentally with *C. obsignata* from the peafowl and infected naturally with this parasite from the pigeon. Although peafowls were not available for similar experiments, one could perhaps safely assume on the basis of the results reported here that peafowls also may acquire infections with these parasites from chickens.

102. **Value of Piperazine Dihydrochloride in the Treatment of Cooperiasis in Calves.** JOSEPH E. ALICATA, University of Hawaii.

Severe infections with *Cooperia punctata* have been found in Hawaii among dairy calves 4 to 8 months old, and beef calves about 8 months old. Critical tests have been conducted to determine the efficacy of piperazine dihydrochloride ("Dowzene DHC," 51% base) against this parasite. Seven 7-week-old and weaned calves were each experimentally infected with about 75,000 infective *Cooperia* larvae. The drug was administered 3 weeks later to 2 calves at the rate of 15 g base per 100 lbs of body weight and to 5 calves at the rate of 20 g base per 100 lbs. The drug was dissolved in water and administered as a drench. The average percent efficacy, determined from worms eliminated with the feces and remaining at necropsy, was 55.5 (42–69) with the lower dosage, and 87.8 (79–99) with the higher dosage. Most of the remaining worms were males.

Increased body weight has been noted among 3 groups of 6-month-old calves treated with piperazine dihydrochloride (20 g base per 100 lbs). The calves had a natural predominant infection with *Cooperia*, and a light infection with *Bunostomum* and *Strongyloides*. The average daily body gain (lbs) for a period of 90 days following treatment was 1.24 (group I, 30 calves), 1.21 (group II, 15 calves) and 0.72 (group III, 25 calves) for the treated calves, and 1.09, 0.98 and 0.58 for the corresponding untreated calves. The average pretreatment egg count per gram of feces for *Cooperia* of 10 unselected calves for each of the 3 groups was 774, 864, and 293, respectively.

(Supported in part by the Western Regional Research Project W-35, Internal Parasites of Ruminants.)

103. **Modification of the Course of Infection of *Plasmodium lophurae* by the Injection of Components of the Erythrocyte.** R. BARCLAY MCGHEE, University of Georgia.

Typical infections of ducks with *Plasmodium lophurae* are marked by a hemolytic crisis and anemia. In duck embryos by way of contrast, there is no visible intravascular hemolysis and the red blood cell number at death is approximately that recorded at the beginning of infection. The picture presented is similar to that seen in infected ducklings transfused with homologous or heterologous erythrocytes, except that the embryo, as a result of hyperactive hemapoeisis is transfusing itself. If infected ducklings are transfused with ghost rather than intact erythrocytes, there is a delay in the rise of parasitemia. Acting on the belief that the cell or its ghost contains a substance or substances attractive to the merozoites, various components of erythrocytes were injected into infected ducks and their effects on the parasitemia determined. To date it has been found that lecithin does not appreciably alter the course of infection, suggesting that this substance is not the cell component attacked by the merozoite in its entry into the erythrocyte.

104. **Distribution of Sexual and Asexual Stages of *Plasmodium relictum* in the Pigeon, *Columba livia*.** JOHN N. FARMER, Iowa State College.

Distributional variations of various stages of *Plasmodium relictum* strain 1-B have been noted in the pigeon. Enumerative data were obtained to determine the extent and specificity of these variations. Peripheral blood films and tissue impressions of liver, spleen, kidneys, lungs and brain of infected birds were examined. Liver punctures of living birds allowed comparison of liver blood films with simultaneously acquired peripheral blood films.

These data indicate that: (1) the percentages of uni-nucleate stages, gametocytes and parasitized cells recorded from the peripheral blood correspond to those recorded from the liver; (2) during schizogony, segmenters are evenly distributed in the blood of those tissues specified above. However, variation between percentages of these stages becomes noticeable as segmentation progresses. Following segmentation, these variations disappear; (3) gametocyte numbers are consistently lower in the visceral circulation than in peripheral blood, especially in liver, kidneys and lungs; (4) gametocyte numbers in both peripheral and visceral circulation decrease during the course of infection; (5) exo-erythrocytic schizonts are demonstrable within brain capillaries of infected birds that die. They may sometimes be observed to a lesser degree in liver, kidneys and lungs of such birds; (6) a fragment of an exo-erythrocytic schizont was observed in a blood film obtained from the liver on the 13th day of infection; (7) statistical evaluation indicates all recorded variations fall within accepted limits and are attributable to random variation.

Thus, occasional distributional variations of various stages of *P. relictum* are to be expected, but probably result from a combination of factors within the host, rather than from an inherent characteristic of this strain.

(This study was supported in part by Grant No. E 992-C from the Division of Research Grants, National Institutes of Health, Public Health Service.)

105. **Transaminases in Four Species of Hemoflagellates.** RODRIGO ZELEDON, School of Hygiene and Public Health, The Johns Hopkins University.

Transaminases were investigated in homogenates of the culture forms of four hemoflagellate species by quantitative estimation of the products after separation by paper chromatography. Eleven amino acids and five other amino compounds were tested as NH_2 donors, while alpha-keto-glutarate and pruvate were used as the acceptors. *Schizotrypanum cruzi* and *S. vespertilionis* showed strong transaminase activity in the presence of all the amino acids and in the presence of glutamine and asparagine. In several cases values as high as 50 to 100 μM of the products per mg of nitrogen per hour, were observed. *Endotrypanum schaudinni* exhibited transamination with some of the amino acids, but only glutamic acid and alanine, as amino donors, represented a quantitatively important system. Transaminases in *Leishmania enriettii* are apparently absent or give very low values. None of the species was able to transaminate glucosamine, adenine or cytosine. The significance of the findings, in connection with other metabolic characteristics of the parasites, is being investigated at the present.

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106. **Reduction of Trypanosome Growth-Factor in Rat Serum by Host Starvation.** D. R. LINCICOME AND J. A. HINANT, Naval Medical Research Institute, Bethesda, Md., and Department of Zoology, Howard University, Washington, D. C.

The growth-promoting properties of normal rat serum observed for *Trypanosoma lewisi* in heterologous mouse hosts have been altered or masked by starvation of the rat. The serum from large old male albino rats denied food for 2 weeks supported little or no growth of *T. lewisi* in mice. Trypanosome growth in mice supplemented with serum from rats starved for only 8–9 days was intermediate between that observed for serum from rats starved for 2 weeks and normal serum. Removal of this property by starvation suggests the possibility of determining the nature of this phenomenon either by selective additions to the depleted serum or by selective withdrawal of components from the rat's diet.

107. **Further Observations on the Effects of Chlorophyllin and Hematoporphyrin in Experimental *Trypanosoma congolense* Infections.** F. C. GOBLE AND J. L. BOYD, CIBA Pharmaceutical Products Inc.

In an early study (Goble & Boyd, 1959, Proc. Soc. Exp. Biol. and Med., in press) it was found that treatment of mice, infected with *Trypanosoma congolense*, with chlorophyllins, or with hematoporphyrin, resulted in suppression of parasitemia and sometimes cures. In reversal experiments, designed to show that the activity of these compounds lay in their ability to antagonize heme, difficulties were encountered because of the additive intravenous toxicities of the substances. It was subsequently found that both chlorophyllin and hematoporphyrin were more toxic to mice by the intraperitoneal than by the intravenous route.

Experiments with chlorophyllin demonstrated a differential rate of absorption from the abdominal cavity in mice and rats. In mice most of the injected material seems to remain in the body cavity for a long time and green staining was confined to that region. Although the activity of chlorophyllin could be detected when the material was given intraperitoneally, no cures could be effected using this route even with prolonged treatment. In rats, however, the substance became diffused throughout the body, staining not only the viscera but also causing the animals to appear green externally.

Rats tolerated about twice as much as mice on intraperitoneal treatment, and the curative intraperitoneal dosages for rats infected with the "Lumu" strain were about the same as the curative intravenous dosages for mice with the "Wellcome FN" strain. The chemical and steric characteristics of chlorophyllin and hematoporphyrin, which may account for their ability to antagonize heme, while 7 other porphyrins and the phaeophorbides are ineffective, are matters for speculation.

108. **The Effect of Pyridoxine Deficiency on Mice Infected with the Khartoum Strain of *Leishmania donovani*.** P. ACTOR AND L. A. STAUBER, Bureau of Biological Research, Rutgers, the State University of New Jersey.

The work to be reported concerns the effect of B_6-deficiency on weanling, Swiss Webster, albino mice infected with the Khartoum strain of *Leishmania donovani*. All the animals employed in these experiments were infected intravenously with approximately 5,000,000 parasites. The method for estimating parasite densities (Stauber, 1955) utilized both liver and spleen impression smears. The infection in the normal mouse is characterized by a rise in parasite numbers over 1 to 4 weeks, followed by a number crisis which leads to a low grade chronic

infection of indefinite duration. The absence of pyridoxine from the purified diet employed in these experiments, in addition to the daily subcutaneous administration of desoxypyridoxine, was sufficient to produce a severe B_6-deficiency in 1 week. Appropriate pair-fed and *ad libitum* controls were maintained on complete diets.

Mice made B_6-deficient prior to infection were found to exhibit an increase in the rate of accumulation of parasites as early as 8 days after infection. The daily administration of pyridoxine to the B_6-deficient mice over the next eight days was found to reverse this effect, while the untreated B_6-deficient mice continued to show a greater increase in parasite numbers than the controls.

Animals placed on a B_6-free regime 24 days after infection were later found to harbor approximately 150 times more parasites than the pair-fed controls. The number crisis observed in the controls was not seen in these B_6-deficient animals, where the number of parasites continued to increase throughout the course of the experiment.

This investigation was supported by a research grant (E-92) from the National Institute of Allergy and Infectious Diseases, Public Health Service.

109. **Resistance of the Mouse to Superinfection with the Khartoum Strain of** *Leishmania donovani*. E. FRANCHINO CAPPUCCINO, Bureau of Biological Research, Rutgers, The State University, New Brunswick, New Jersey.

In these studies 2 strains of mice, CF_1 and Swiss Webster, were used. They were infected with the Khartoum strain of *L. donovani*. Estimation of parasite numbers, in spleen and liver, was carried out according to the method described by Stauber (1955). The mice in this experiment were arranged in three groups: (1) animals which were infected intraperitoneally (IP), as the initial infection and were not superinfected; (2) animals which were infected IP for the initial infection and later superinfected intravenously (IV); and (3) animals which were infected only once, IV, at the time of the superinfection. The first group is a control on the course of the initial IP infection and the last group a control on the course of the superinfecting dose of parasites. Groups 2 and 3 were given the superinfecting dose of parasites, IV, 30 days after the beginning of the experiment. Approximately every eight days, until day 60 after superinfection, animals from the 3 groups were sampled for parasite burdens in the spleen and liver. As early as 8 days after superinfection the heightened resistance of the animals previously sensitized (group 2) was clearly evident by lower parasite counts in the organs than in the organs of the controls (group 3). This resistance continued to be evident at every other time interval tested.

Group 1, initial IP infection only, at almost every time interval tested showed only an occasional animal with an occasional parasite. Both strains of mice were shown to acquire resistance to superinfection with *L. donovani*.

(This investigation was supported by a research grant (E-92) from the National Institute of Allergy and Infectious Diseases, Public Health Service.)

110. **The Serum Proteins of Animals Infected with** *Leishmania donovani*. RICHARD N. ROSSAN AND LESLIE A. STAUBER, Bureau of Biological Research, Rutgers, The State University of New Jersey.

The serum protein patterns for eight species of animals inoculated with the Khartoum strain of *Leishmania donovani* were obtained by paper electrophoresis. Approximately 750 serum patterns of uninfected animals, and animals at various stages during infection and superinfection, were analyzed.

In animals (cotton rat, golden hamster, Chinese hamster, chinchilla, mouse and Mongolian gerbil), susceptible to infection with this strain of the parasite, modifications of the serum fractions were observed. However, those animals (guinea pig and rabbit) which apparently are poor hosts for the parasite, gave evidence of little or no alteration of their serum components.

The observed changes of the serum constituents, in the susceptible animals, could be correlated with the duration of the infection, the number of parasites originally inoculated, and the route of parasite inoculation. A common finding, among these susceptible animals, was some degree of albumin depression with a concomitant increase of gamma globulin concentration. Although the concentrations of alpha and beta globulins, and total protein were variable during the course of infection, there was an indication of increasing amounts of these components.

Detailed analyses of the gamma globulin area on the electrophoretic patterns of the infected animals revealed that slow moving gamma globulins were formed in the cotton rat, golden hamster and Chinese hamster, species which are highly susceptible to infection with *L. donovani*.

(This investigation was supported by a research grant, E-92, from the National Institute of Allergy and Infectious Disease, Public Health Service.)

111. **Cannulation of the Colon as an Aid to the Study of Canine Amebiasis.** JACK PUSHKIN, L. H. SAXE AND DONALD R. FOWLER, Department of Pharmacology, West Virginia University Medical Center.

A modified Peterson teflon cannula (Exp. Parasit. **5**: 427–434, 1956) is being used in the quantitative study of amebiasis in dogs to provide a convenient method of inoculation and permit daily sampling of colonic contents. Surgical procedures involve aseptic laparotomy through a right paramedian incision, implantation of a cannula 3–5 cm posteriad of the ileo-colic junction, and withdrawal of the cannula through a lateral puncture wound. Postoperative recovery is without complication and the animal is ready for inoculation within 10–14 days. A diet of canned salmon is fed to all dogs beginning 1 week before inoculation and continuing throughout the period of study. The animals are quantitatively inoculated with approximately 1 million *Entamoeba histolytica* NIH 200 I (provided by Dr. P. E. Thompson, Parke-Davis and Co.). Quantitative determinations are made daily of the number of organisms per 100 mg of colonic contents. Marked fluctuation of amebic populations in the lumen apparently results from the erratic release of trophozoites from the tissues and the flushing of material from the gut. In 6 dogs, the prepatent and incubation periods averaged 3.2 and 5.2 days, respectively. Infections in untreated dogs produced severe, progressive dysentery. Autopsies after 1–4 weeks revealed no gross enteric lesions; however, minute hemorrhagic lesions were found throughout the colon and rectum. In 2 dogs with typical infections, treated with carbarsone (30 mg per kg per day) for 5 days, trophozoites were not found after the first treatment and stools were asymptomatic within 48 hours.

(This investigation was supported in part by Research Grant E-1139 (C2) and Graduate Training Grant 2G-76, National Institutes of Health.)

112. **Further Observations on Pathogenicity of *Trichomonas gallinae* and *T. vaginalis* to mice.** B. M. HONIGBERG, The Johns Hopkins University and University of Massachusetts.

Since the last report (Honigberg and Braunthal, 1957, J. Parasit. **43** (supp): 40.) the virulence of several additional strains of *Trichomonas gallinae* and *T. vaginalis* was evaluated by measuring the volumes of subcutaneous lesions in C57 B1/6 mice inoculated with flagellates grown in agar-containing media. In all instances the degree of virulence to mice corresponded to that exhibited by the trichomonads to the natural hosts from which they were isolated. It could be demonstrated also that there was no appreciable change in pathogenicity of Jones' Barn strain after four serial passages in mice.

Most recent observations indicate that all strains of both species grown for one week on simplified trypticase (STS) or CPLM media without agar, and innoculated in such media into mice, cause significantly smaller lesions than those which result from injection of the same strains maintained on agar-containing media. Furthermore, there is a progressive attenuation of the strains proportional to the number of transfers on media that do not contain agar.

If Jones' Barn strain is grown for several transfers on STS-type medium in which methyl cellulose, mucin, or gelatin are substituted for agar, the type of substance incorporated in the medium has a direct bearing upon the volume of subcutaneous lesions. Although none of the substances is as effective as agar, the presence of methyl cellulose in the medium stimulates the formation of sizable lesions. Mucin appears to be less effective, and the volumes of abscesses produced in the presence of gelatin are indistinguishable from those that result from inoculation of flagellates grown in media devoid of any viscous substance.

A complete report on our experiments dealing with pathogenicity of *T. gallinae* and *T. vaginalis* to mice is now in press.

(This investigation was supported by Research Grants, E-742 and E-783, from the National Institute of Allergy and Infectious Diseases, Public Health Service.)

113. **Observations on Thermal Resistance of *Trichomonas gallinae* and *T. vaginalis*.** M. H. SATTI AND B. M. HONIGBERG, The Johns Hopkins University, Ministry of Health, Khartoum, Sudan and University of Massachusetts. (5 min.)

A series of experiments has been conducted to test the resistance of *Trichomonas gallinae* (Jones' Barn strain) and of *T. vaginalis* (TVC strain) to various temperatures under several environmental conditions. The survival of the flagellates was ascertained by finding motile organisms on microscopic examination after the experimental treatment, as well as by subculture on a suitable medium (BBL fluid thioglycollate with 5 percent normal horse serum, pH 7.0–7.3 or 5.8–6.0, depending upon the species). Our observations indicate that the latter method is far more dependable than the former. The preliminary results suggest that *T. gallinae* (about 10^6 organisms per ml.) can survive up to at least 4 hours of freezing at –15° C in tap or glass distilled water (pH 7.2), and up to at least 16 hours in Gey's or Earle's Balanced

Salt Solution (BSS). After shorter periods of freezing, some motile organisms are usually found when the thawed suspension is brought up to room temperature; after prolonged freezing, although no motile organisms are seen, rich cultures of trichomonads may be obtained on thioglycollate medium. The incubation periods increase in proportion to the times for which the organisms are frozen. In some instances, incubation periods of 7–8 days may be required before the cultures become positive for flagellates. *T. vaginalis* (about 10^6 organisms per ml.) has been found to survive for at least 1½ hours in Earle's BSS at –15° C. Further experiments are being carried out to test the survival limits of the two species in tap and glass distilled water, as well as in BSS at –15° C and at higher temperatures.

(This investigation was supported by Research Grants, E-742C3 and E-783, from the National Institute of Allergy and Infectious Diseases, Public Health Service.)

114. **Epidemiological and Serological Observations on a Toxoplasmosis Outbreak in Dogs.** J. R. LINDSEY, School of Veterinary Medicine, Alabama Polytechnic Institute, Auburn, Alabama.

Two English Shepherd puppies showed distemper-like signs of illness at 103 days of age. One died following an illness of 6 days, and *Toxoplasma* organisms were isolated from tissues taken at necropsy. Serum from the other puppy gave a Sabin-Feldman dye test titer of 1:1024, and the owner requested that it be euthanatized. *Toxoplasma* organisms were demonstrated by mouse inoculations.

The 2 affected puppies had been kept at three different premises prior to their illness. Serological tests were performd on serum from dogs at these three locations. Serum from the mother of the litter had a negative dye test and a fluorescence inhibition titer of 1:256.

The mother of the litter became noticeably ill 6 months after whelping. At that time a litter mate which had been kept by the original owner was said to have been "sick for several days." Treatment of this animal with Daraprim and sulfadiazine for 2 weeks was ineffective. Serological tests were done on serum from these two dogs at intervals during the course of their illness. These findings will be presented along with the results of animal inoculations using tissues taken at necropsy. The results of serology and animal inoculations on other associated animals will also be given.

115. **The Relationship of *Toxoplasma* Dye Test and Neutralization Antibodies.** LEON JACOBS, JACK S. REMINGTON, HERBERT KAUFMAN,* MARJORIE L. MELTON, AND MILFORD N. LUNDE, U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Laboratory of Parasitic Diseases, Bethesda, Maryland.

Since the dye test requires a heat-labile accessory factor and the dermo-necrotic neutralization test requires active serum, the two tests may measure the same antibody. However, this relationship has not yet been demonstrated, and in tissue culture systems little inhibition of *Toxoplasma* is found in the presence of dye test antibodies and accessory factor (Vischer and Suter, 1954, Proc. Soc. Exp. Biol. Med. **86:** 413–419).

To equate dye test antibodies with neutralizing antibodies, *Toxoplasma* from mouse peritoneal exudate were filtered through a large-pore filter to remove infected leucocytes, incubated in active and inactive immune serum, and then titrated for their infectivity to mice. In other experiments, parasites liberated from micro-isolated cysts were similarly tested, and in further work the organisms were titrated in progressive dilutions which were incubated with undiluted positive serum. The results indicate that dye test antibody destroys *Toxoplasma*. This supports the concept of Lelong and Desmonts (1952, Compt. Rend Soc. Biol. Paris **146:** 207–209) that partial lysis of the parasites occurs, rendering them unstainable with methylene blue.

116. **Hemagglutination and Dye Test Antibodies in Experimental Toxoplasmosis Produced by Virulent and Avirulent Parasite Strains.** MILFORD N. LUNDE, U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Laboratory of Parasitic Diseases, Bethesda, Maryland.

In one monkey and in rabbits infected with the RH strain of *Toxoplasma*, the hemagglutination test became positive 4 to 5 days after the initial appearance of dye test antibodies. This pattern of antibody response is similar to that noted in 2 acute human cases of toxoplasmosis. In the monkey an inhibitory substance appeared in the serum on days 3 and 4 after infection; this blocked hemagglutination with a standard positive serum and may be representative of an antigenic phase. On day 7 hemagglutinating ability was present.

* Ophthalmology Branch, National Institute of Neurological Diseases and Blindness.

In RH infected rats, the hemagglutination test became positive in approximately 3 weeks, while the dye test became positive within a few days after initial infection. Rats infected with a relatively avirulent strain, 113-CE, did not show a positive hemagglutination test until 10 weeks after infection. Treatment of rat serums with kaolin sometimes resulted in hemagglutinating ability not previously discernible, but this was not consistent.

In pigeons, however, antibodies were demonstrable by the hemagglutinaiton test 1 to 2 days before they appeared in the dye test. No apparent difference was noted in antibody response between virulent and avirulent strains in pigeons.

117. **Congenital Transmission of Toxoplasmosis from Mother Animals with Acute and Chronic Infections.** JACK S. REMINGTON, MARJORIE L. MELTON, AND LEON JACOBS, U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Laboratory of Tropical Diseases, Bethesda, Maryland. (Abstract withdrawn by authors.)

118. **Parasitemia in Late (Chronic) Infection with *Toxoplasma* Strains of Low Virulence.** JACK S. REMINGTON, MARJORIE L. MELTON, AND LEON JACOBS, U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Laboratory of Tropical Diseases, Bethesda, Maryland. (Abstract withdrawn by authors.)

119. **The Course of Infection of *Babesiosoma* sp. Jakowska and Nigrelli (1956) in Experimentally Infected Amphibia.** STELLA M. SCHMITTNER, University of Georgia.

While conducting a routine survey of the blood sporozoans of amphibians, a hitherto unreported intra-erythrocytic protozoon of *Rana pipiens* was discovered. The incidence of the natural infection was 0.95 percent of the 423 frogs examined; the highest parasitemia was less than 1.0 percent. The morphological characteristics of the asexual forms, in natural and experimental infections, resemble those of *Babesiosoma*.

Successful transmission to individuals of the same species and to other amphibians has been effected by intra-venous, sub-cutaneous and intra-peritoneal injections of infected blood. The parasitemia of an experimental infection may reach 28 percent in the natural host. In some instances, a relatively high parasitemia is accompanied by an increased activity of the hemocytopoietic system resulting in a large number of immature erythrocytes being present in the circulating blood. At this time the parasitemia is greatly reduced but continues at a low level. Gametocytes are the dominant form in infections of a long duration. To date, no *R. pipiens* has shown any pathological condition which could be attributed to its experimental infection.

120. *Hepatocystus* (=*Plasmodium*) *kochi* **in the Dog Face Baboon,** *Papio doguera*. JOSEPH H. MILLER, Louisiana State University School of Medicine.

Blood smears (one thick and one thin) were made from each of 122 baboons captured and autopsied in southeastern Kenya. Giemsa staining revealed gametocytes of *Hepatocystis* (=*Plasmodium*) *kochi* in the blood of 92 (75.4 percent) of the 122 baboons. Infections were observed in infants weighing 2 to 3 pounds. However, the prevalence of infection was greatest in the older baboons.

Garnham (1952, Trans. Roy. Soc. Trop. Med. Hyg. **46:** 535) described an unusual form of merocyst in the livers of two baboons (*Papio papio*) that had been caged for a long time. The merocysts were large (4 mm in diameter) and were multilocular in contrast to the small unilocular merocysts described from the livers of *Cercopithecus* monkeys. Garnham concluded that the unusual form of merocyst was most likely due to the unnatural conditions in which the baboons were living rather than to a special stage or subspecies of the parasite.

In the present study, baboons were usually autopsied a few hours after capture. Merocysts in the livers of infected baboons were of large size (4 mm in diameter) and were all multilocular. Therefore, this type of merocyst may represent a special stage or subspecies of *H. kochi* in the genus *Papio*.

Five infecetd baboons weighing about 15 pounds each were fed 0.5 g chloroquine dihydrochloride and 0.26 g primaquine diphosphate in candy for 14 days and then autopsied. The blood of all animals still contained gametocytes of *H. kochi*, and apparently unchanged merocysts persisted in the liver of the treated baboons.

121. **Potentiation of Antimalarial Activity of Chloroquine Diphosphate Against** *P. berghei*. L. E. GAUDETTE AND G. ROBERT COATNEY, National Institutes of Health, Bethesda, Maryland.

Essential to a program for the mass eradication of malaria is an antimalarial drug of prolonged activity after a single loading dose. A single dose of chloroquine can provide effective plasma concentrations for nearly 20 days. The studies cited in this communication represent an attempt to obtain even more prolonged activity.

The duration of antimalarial activity of orally administered chloroquine was compared in mice inoculated with *P. berghei* with and without the administration of various prolonging agents (SKF 525-A, Lilly 18947, Iproniazid and Isoniazid. None of the prolonged agents demonstrated any antimalarial activity over a wide range of concentrations. The level of chloroquine employed, 100 micrograms/20 g mouse, did not clear the blood of the infection, but merely delayed parasite development. In the presence of prolonging agents SKF 525-A, Lilly 18947, and Isoniazid complete suppression occurred, the number of days being directly related to the level of prolonging agent administered. Iproniazid showed no such potentiation of chloroquine.

An insight into the mechanism of action of these drug combinations was obtained by measuring the plasma levels of chloroquine in male albino rabbits which received, respectively, (1) 100 mg chloroquine and (2) 100 mg chloroquine and 200 mg SKF 525-A. The animals treated with both chloroquine and SKF 525-A demonstrated a higher and more prolonged plasma level. The increased duration of action of chloroquine caused by SKF 525-A is evidently due only to inhibition of its metabolic transformation. The enzyme systems involved are presently under investigation.

122. **The Mode of Action of Antimalarial Drugs.** KARL A. SCHELLENBERG AND G. ROBERT COATNEY, National Institutes of Health, Bethesda, Maryland.

Suspensions containing chicken blood infected with *Plasmodium gallinaceum*, P^{32} labelled orthophosphate, and antimalarials were incubated at 37° C for 24 hours. Nucleic acids were isolated according to Davidson and Smellie (1952, Biochem. J. **52:** 594). The ratios of specific activity of the DNA and RNA fractions to that of the acid soluble phosphorus were taken as synthesis of DNA and phosphate exchange of RNA, respectively. Quinine, quinidine, Atabrine, and chloroquine had little effect at 10^{-6} M, but at 10^{-5} M and higher concentrations they inhibited phosphate incorporation into the nucleic acids. At 10^{-5} M the inhibition of DNA synthesis was 80 to 100 percent and RNA exchange, 60 to 80 percent. Daraprim had little effect at 10^{-9} M and at 10^{-8} to 10^{-7} M it inhibited DNA synthesis 80 to 90 percent without affecting RNA exchange. Primaquine, paludrine, pentachlorophenol, tetracycline, chloromycetin and sulfadiazine were ineffective at 10^{-5} M or less.

The results are consistent with a direct action by certain drugs on nucleic acid metabolism. Thus, drugs which are rapidly acting clinically, such as quinine, chloroquine, and Atabrine, directly inhibit RNA exchange and DNA synthesis, whereas the slower acting Daraprim inhibits DNA synthesis only. The inactivity of primaquine and paludrine is consistent with their well-known formation of active metabolites.

123. **The Effect of Terephthalic Acid and Source of Calcium on the Anticoccidial Activity of Chlortetracycline.** EDWARD J. BURDEN AND EMANUEL WALETZKY, Agricultural Division, American Cyanamid Company, Pearl River, N. Y.

One-week-old chicks inoculated with large numbers of *Eimeria tenella* oocysts were treated with various concentrations of chlortetracycline hydrochloride* (CTC), with and without different levels of terephthalic acid, in drug diets for 10 days. On the basis of survival and weight gains, 0.5 percent terephthalic acid enhanced the anticoccidial activity of CTC approximately two-fold. It appears that lower concentrations of TPA also increase the activity of CTC, although probably to a lesser degree.

CTC activity, with and without 0.5 percent TPA, was compared in low calcium (ca 1 percent) diets in which the calcium was derived mainly from either $CaCO_3$ plus $CaHPO_4$, or $CaSO_4$. On all diets, TPA enhanced the anticoccidial activity of CTC two-fold; however, the $CaSO_4$ diet seemed to increase activity more than the $CaCO_3$ diet. Preliminary data also suggest decreased activity with usual calcium concentrations (1.4 percent as carbonate plus phosphate) in the diet. The above results confirm, in part, those of E. H. Peterson, et al (1959, Sci. **38:** 235–237.)

124. **The Prophylactic Activity of 1-maleinyl-4-(3′-chloro-4′-methyl-phenyl)-Piperazine (Hoechst S 688) in Experimental Schistosome Infections.** G. W. LUTTERMOSER, J. I. BRUCE, AND D. B. MCMULLEN, National Institutes of Health and Walter Reed Army Institute of Research.

* The trademark of the American Cyanamid Company for the antibiotic chlortetracycline is Aureomycin.

DeMeillon et al (1956) and Lammler (1958) have demonstrated that the oral administration of a single dose of either of the Hoechst compounds S 616 or S 688 (1-maleinyl-4-(3'-chloro-4'-methyl-phenyl)-piperazine) within 4 days after exposure to cercariae of *Schistosoma mansoni* (Liberian strain), protected mice from developing this infection.

S 688 was given orally to mice from the day before exposure to the 4th day following exposure to the cercariae of *S. mansoni* (Puerto Rican strain). Two months after exposure, the infection present in the treated mice was compared with that in the non-treated controls. No prophylactic effect was observed when the compound was given 24 and 6 hours before exposure. Some prophylactic effect resulted from administration of S 688 at the time of exposure and this effect markedly increased when the chemical was given 6 to 96 hours after exposure. The greatest protection was observed following a single dose of 120 mg per kg given at 72 hours. A 60 mg per kg dose at 24, 48, and 72 hours after exposure completely protected one group of animals, and only one worm was found in 7 mice of another group, while the controls averaged 45.2 parasites each.

The *S. mansoni* infection apparently developed normally in 3 monkeys which had ingested either 100 mg per kg 24 hours after exposure or 240 mg per kg on each of the 3 days following exposure or 125 mg per kg on each of 5 days starting on the day of exposure.

Likewise 2 dogs were not protected by 1 or 2 oral doses of S 688 given on the days after *S. japonicum* cercariae (Formosan strain) were placed on their skin.

125. **The Curative Activity of 1-maleinyl-4-(3'-chloro-4'-methyl-phenyl)-Piperazine (Hoechst S 688) in Experimental Schistosome Infections.** JOHN I. BRUCE, Walter Reed Army Institute of Research, GEORGE W. LUTTERMOSER, National Institutes of Health, AND DONALD B. MCMULLEN, Walter Reed Army Institute of Research.

Oral regimen of the compound 1-maleinyl-4-(3'-chloro-4'-methyl-phenyl)-piperazine (Hoechst S 688) were found to have a strong chemotherapeutic effect on mature infections of *S. mansoni* (Puerto Rican strain) in white mice and monkeys. The oral administration of single dosage of this compound (72, 120, 240 and 500 mg per kg) completely cleared most of the mice with mature infections. The dosage level necessary to bring about clearance of monkeys of all their schistosome parasites approached toxic levels. Three monkeys with mature infections of *S. mansoni* were treated with this compound. One of these animals received a dose of 100 mg per kg for 5 days which did not completely cure the infection. The infections in two remaining animals were not eliminated by 2 daily doses (240 mg per kg) of this compound, but the egg counts were markedly reduced. A second regimen of 5 daily doses (240 mg per kg) killed all but a single male worm of an estimated 329 worms in these 2 monkeys.

There was no evidence of curative effect on a *S. japonicum* infection in a dog which was given a low dosage of the chemical.

The present results are in agreement with those of de Meillon, England and Lammler (1956) and Lammler (1959) who discovered the curative activity of the compound against the Egyptian and Liberian strains of *S. mansoni* in rodents and monkeys.

126. **The Effects of Reference Anthelmintics Against *Nematospiroides dubius* and Oxyurids in Mice Relative to Screening Procedures for New Drugs.** HARLEY G. SHEFFIELD, JACK E. MEISENHELDER, AND PAUL E. THOMPSON, Research Division, Parke, Davis & Co., Detroit, Michigan.

Eleven reference anthelmintics were tested against experimental *Nematospiroides dubius* infections and naturally-occurring *Syphacia obvelata* and *Aspiculuris tetraptera* infections in mice. Piperazine, phenothiazine, tetrachlorethylene, carbon tetrachloride, hexylresorcinol, gentian violet, pyrvinium chloride, dithiazanine iodide and bephenium embonate were active against one or more of the worms, but santonin and oil of chenopodium were not appreciably active.

The study was directed toward determining the susceptibility of the three test worms to representative reference drugs and the influence of treatment regimen on activity.

Inasmuch as neither gavage nor drug-diet treatment proved to be optimal for all drugs and no single worm was optimal for showing activity by all drugs, a combination of these regimens against all three worms would seem to be preferred for the adequate screening of new substances.

127. **The Comparative Anthelmintic Activity of Four Bephenium Salts.** M. D. YOUNG AND G. M. JEFFERY, National Institutes of Health, J. E. FREED, W. G. MOREHOUSE, AND R. S. JOHNSON, South Carolina State Hospital. (Abstract was not for publication.)

128. **Anthelmintic Activity of a New Organic Phosphate in Cattle and Sheep.** JAMES

F. LANDRAM, Agricultural Research Department, The Dow Chemical Company, Lake Jackson, Texas, AND ROBERT J. SHAVER, Agricultural Research Department, The Dow Chemical Company, Midland, Michigan.

The activity displayed by organic thiophosphate compounds against gastrointestinal parasites of ruminants has been of extreme interest. Recently a very promising organic phosphate compound was discovered. This compound, 4-tert-butyl-2-chlorophenyl methyl methylphosphoramidate, has shown promising anthelmintic activity in cattle and sheep. Preliminary trials have involved approximately 700 cattle and over 1,000 sheep. Good to excellent anthelmintic activity was obtained at the following dosage levels: Cattle, 30–50 mg per kg and 50–125 mg per kg in sheep. Data are presented summarizing the results of anthelmintic efficiency trials with this organic phosphate in cattle and sheep.

129. **Anthelmintic Activity in Cattle and Sheep of Three New Phosphoramidothioates.** JAMES F. LANDRAM, Agricultural Research Department, The Dow Chemical Company, Lake Jackson, Texas.

Good anthelmintic activity was demonstrated against some of the parasitic nematodes of cattle and sheep by 3 new phosphoramidothioates, DOW-ET-70 (0(4-tert-butyl-2-chlorophenyl), O-methyl phosphoramidothioate), Dowco® 105 (O(4-tert-butyl-2-chlorophenyl), O-methyl, ethyl phosphoramidothioate, and Dowco 109 (O(4-tert-butyl-2-chlorophenyl), O-methyl, methyl phosphoramidothioate). Single oral doses of 50 mg per kg and above in cattle and 100 mg per kg and above in sheep resulted in a 90 percent reduction or better in the parasite egg counts one week after treatment.

Critical studies in cattle indicate good removal of *Haemonchus placei, Ostertagia ostertagia, Oesophagostomum radiatum* and *Cooperia* spp., fair removal of *Trichostrongylus axei,* and little or no effect on *Bunostomum phelbotomum.*

130. **Critical Tests on the Organic Phosphate Insecticide, Dimethoate®, Against *Gastrophilus spp.* in the Horse.** J. H. DRUDGE, S. E. LELAND, JR., Z. N. WYANT AND G. W. ELAM, University of Kentucky, Lexington, Kentucky.

A series of 5 trials administering single doses via stomach tube at the rate of 10, 20, 40, 60, and 80 mg per kg body weight was completed. Dosages of 40 mg per kg and above 100 percent effective in removing 3d instar *Gastrophilus nasalis.* None of this species was harbored by the animal receiving 20 mg per kg and the 10 mg per kg dose failed to remove any. Against 3d instar *G. intestinalis,* a much lower order of activity was recorded with the maximum percent removal being 50 percent at 60 mg per kg. No *G. intestinalis* were removed by the 80 mg per kg dose. Symptoms of toxicity accompanied the 60 mg per kg dose and severe symtoms followed the 80 mg per kg dose.

In 2 tests, repeated small doses administered in the feed markedly increased the efficacy. In one horse, three daily 20 mg per kg doses in the grain ration removed 100 percent of both 2d and 3d instar *G. nasalis* and 100 percent and 92 percent of 2d and 3d instar *G. intestinalis,* respectively. In a similar trial in which four 20 mg per kg doses were fed the same removal percentages were observed except for 3d instar *G. intestinalis* which was increased to 98 percent. Both animals showed softening of the feces during and 2 days following the treatment period.

131. **The Effects of Caricide*, Diethylcarbamazine, on Experimental Infections of *Haemonchus contortus* and *Trichostrongylus* spp in Lambs.** I. B. WOOD, J. EMRO, W. S. WALLACE AND E. WALETZKY, Agricultural Division, American Cyanamid Company, Pearl River, N. Y.

Laboratory trials showed that single oral doses of 15 mg per kg diethylcarbamazine citrate (equivalent to 7.5 mg per kg, diethycarbamazine base) were highly effective in reducing egg counts and adult populations of *H. contortus* from 90 to 100 percent in all of 14 lambs. Higher doses, 250 and 500 mg per kg, of diethylcarbamazine citrate, suggested action comparable to that of phenothiazine, at 1000 mg per kg, against *Trichostrongylus axei* and *T. colubriformis.* The action of diethycarbamazine against *H. contortus* when administered by different routes will be discussed.

Data to be reported in this paper further demonstrate that the anthelmintic spectrum of diethylcarbamazine is not a direct function of its piperazine content, as piperazine has been reported inactive against these nematodes.

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* The trademark of the American Cyanamid Company for diethylcarbamazine is Caricide.

132. **The Efficacy of Cyanacethydrazide in Calves Experimentally Infected with** *Dictyocaulus viviparus.* R. RUBIN, Colorado State University.

Prior to the recent development of cyanacethydrazide, which offered promise of controlling certain lungworms in domestic animals, there was no anthelmintic suitable for the removal of most lungworms.

In an attempt to further evaluate this chemical, experiments involving 54 calves have been completed. The calves, in groups of 6 to 12, were exposed to 13,250 to 15,000 infective larvae of *Dictyocaulus viviparus.* Each group also had 1 to 3 unexposed controls. Of the exposed animals, one-half were treated with cyanacethydrazide; the other half were not. The treated groups were given three daily subcutaneous injections of cyanacethydrazide at the rate of 15 mg per kg, starting either at 14 days following exposure, at 20 or 21 days following exposure, or at 5 days following the onset of patency of the lungworm infection.

In this series of experiments the efficacy of treatment was based on a comparison of the total number of worms recovered at necropsy in the treated and untreated groups. Necropsies were performed usually 2–3 weeks following treatment.

These post-mortem worm counts indicate cyanacethydrazide to be ineffective when given starting 14 days after exposure, and only moderately effective when given starting either at 20 or 21 days following exposure. When given starting 5 days following the beginning of patency, cyanacethydrazide treatment in most instances considerably reduced the total number of worms as compared with the numbers recovered from the infected, untreated calves.

133. **The Efficacy of Piperazine Citrate and Phenothiazine Against** *Heterakis gallinae* **and** *Ascaridia galli* **in Chickens** M. L. COLGLAZIER, F. D. ENZIE, A. O. FOSTER, AND D. E. THOMPSON, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

Because of conflicting reports on the anthelmintic action of piperazine and phenothiazine in poultry, critical trials were made with the chemicals in chickens.

Piperazine citrate, given by capsule in single doses containing 100 mg piperazine, removed 45 percent (343) of 751 *Heterakis gallinae* from 11 chickens; and 200-mg doses removed 66 percent (1,089) of 1,644 Heterakis from a similar group. Both doses were completely effective against *Ascaridia galli.* Given in drinking water for 24 hours at 0.05 percent piperazine base, the chemical removed 45 percent (319) of 684 Heterakis from 8 birds and 99 percent (740) of 748 *Ascaridia* from 6. The birds consumed an average of 150 mg piperazine. When the concentration was increased to 0.1 percent, the chemical removed 19 percent (222) of 1,148 *Heterakis* from 13 birds and 96 percent (23) of 24 *Ascaridia* from 4. The birds consumed an average of 240 mg piperazine, although total water consumption was slightly lower than in the previous group.

Phenothiazine (N.F. powder, about 10 micron particle size), given in single doses of 0.5 gram in hard gelatin capsules, removed 39 percent (128) of 326 Heterakis from 6 chickens and 21 percent (4) of 19 Ascaridia from 2. One-gram doses removed 94 percent (865) of 913 *Heterakis* from 5 birds and 24 percent (5) of 21 *Ascaridia* from 2. Given at 0.74 percent of the feed for 3 days, the chemical removed 86 percent (188) of 217 *Heterakis* and 29 percent (23) of 78 *Ascaridia* from 6 birds.

Single 1-gram doses of a 7:3 mixture of phenothiazine and piperazine citrate removed 94 percent (723) of 768 *Heterakis* from 6 birds and all of 91 *Ascaridia* from 3. Comparable results were obtained against both species with 0.75-gram doses of a 4:1 mixture of the 2 chemicals.

134. **Toward Effective Use of Laboratory Cultures of** *Pratylenchus.* J. D. TINER, Rutgers University.

An antibiotic-type "spot-plate" test that, instead of a micro-organism, utilizes a pure culture of an invertebrate as this develops through an entire life cycle is yet to be devised. Cultures of *Pratylenchus* on sterile excised roots (Mountain, 1955, Proc. Helm. Soc. Wash. **22**: 49) seem suitable for such a test. Initial efforts to employ these cultures in toxicologic work revealed that use of macroscopic lesions as inoculum and then measurement of the spread of lesions on a newly infected root can detect some active substances at 100 ppm. Infection of roots with an aliquot from a standardized axenic suspension of nematodes would permit counts of progeny after an appropriate time interval. However, unless there is improved instrumentation, tests on roots in agar may be slow to gain acceptance because of a high labor cost per fact established.

I plan to utilize the cultured root to position the nematodes in a flowing stream that will be a constant chemical environment and to use hermetic sealing to exclude contaminants and to confine volatile toxicants. A flow-process apparatus that raises corn roots in sealed systems has been constructed. Problems relative to its use in connection with various genera of parasites

can be enumerated.

(This investigation supported by research grant E-1552 from the National Institute of Allergy and Infectious Diseases, U.S.P.H.S.).

135. **Parasitological Speculations and Patterns.** A. O. Foster, Beltsville Parasitological Laboratory, Beltsville, Maryland. (No abstract)

136. **Differentiation of Trichomoniasis and Pox Infection.** L. N. Locke, C. M. Herman and E. S. King, Jr., Patuxent Research Refuge, Laurel, Maryland.

Although pox infection in mourning doves (*Zenaidura macroura*) usually produces nodular growths upon the eyelids, base of the beak, or along the top of the head, highly virulent pox strains may cause only caseous lesions in the mouth, somewhat similar to those of trichomoniasis. Field biologists working on mourning dove problems have mistaken the typical nodular pox lesions for lesions of trichomoniasis.

Sections of pox nodules strained with hematoxylin and eosin show an increased thickness of the stratum germinativum, elongated rete pegs, and a loss of the stratum corneum. The eosinophilic cytoplasmic inclusion bodies of pox are seen in the cells of the stratum germinativum. Impression smears of the nodular material stained with Wright's stain show yellow-greyish cytoplasmic inclusion bodies.

Trichomoniasis lesions, when sectioned, are typical examples of caseous necrosis with loss of the normal architectural outline of the tissue. At the edge of the lesion there is some fibrous reaction. Toward the center the cell nuclei become intensely darker staining (pycnotic) and finally undergo karyorrhexis. No inclusion bodies are seen.

137. **Parasites of the Raccoon,** *Procyon lotor*. Gordon Marston Clark and Carlton M. Herman, Patuxent Research Refuge, Laurel, Maryland.

At least 76 species of parasites have been reported from raccoons. These include 4 species of protozoa, 27 nematodes, 20 trematodes, 7 cestodes, 3 acanthocephala, and 15 arthropods. In many cases these represent single reports. In other cases some of the parasites are known to be of frequent occurrence and broad geographical range on the basis of several surveys that have been conducted.

During the past 30 years 260 raccoons have been examined for parasites at the Patuxent Research Refuge. While most of these animals were collected on the refuge, several were from other localities in Maryland and a few from outside this state. The known distribution and occurrence of parasites of the raccoon are presented on charts and representative specimens of some of those collected at the Patuxent Research Refuge are demonstrated.

141. **Studies on Avian Filarial Worms of the Subfamily Splendidofilariinae (Nematoda: Dipetalonematidae).** J. Adeniran Odetoyinbo and Martin J. Ulmer, Iowa State College.

Examination of 62 bronzed grackles (*Quiscalus quiscula versicolor*) trapped in the vicinity of Ames Iowa (1957–59) indicates that these birds are hosts for microfilariae and adult dipetalonematid worms of at least 2 species. 35 birds contained microfilariae in the peripheral blood, and 3 were infected with microfilariae of 2 types. Of the two types of microfilariae recovered, one is sheathed and blunt at both ends. The second type, far less common, is also sheathed but pointed posteriorly. Experiments were conducted on the periodicity of microfilariae of the first type, and blood films were prepared every 2 hours for 72 consecutive hours. Results of these studies show a definite increase in number of microfilariae in peripheral blood between 8PM and 6AM.

Adult worms are remarkably localized in the avian host. They vary in number (from 3 to 32 in birds examined thus far) and invariably inhabit the cerebral hemispheres. Most frequently they occur in the deeper portions of the sagittal fissure separating the cerebral hemispheres, but may be found, too, at the posterior border of the hemispheres where they lie immediately beneath the pia mater. Most of the adult females recovered from the brain are those producing microfilariae of the type characterized by blunt anterior and posterior ends.

Longevity of microfilariae and adults in dead infected birds kept under refrigeration is unusual. Microfilariae are still active in partially clotted blood of the heart for as long as 7 days after death of the avian host. Living adults have been recovered from the brain of birds three days after death.

Life cycle studies of these dipetalonematids are in progress.

143. **Nematodes from Some Captive Animals.** Benedict J. Jaskoski, Loyola University, Chicago.

Some cases of nematodiases previously unreported from this country are demonstrated. An infestation of an orang-utan (*Pongo pygmaeus*) with large numbers of *Abbreviata caucasica* (von Linstow, 1902) is shown. A heavily-infested Egyptian cobra (*Naia haje*), besides harboring *Polydelphus najae* Mosgovoy, 1951, *Hexametra quadricornis*, and *Kalicephalus parvus* Maplestone, had the pentastomid *Armillifer annulatus* (Baird, 1853). A created porcupine passed specimens of *Welcomia evoluta*.

(This project supported by a grant-in-Aid from The Society of the Sigma Xi. Identifications were made by Mrs. M. B. Chitwood, USDA, Beltsville, Md.)

144. **Ultrastructure of the Excretory System of Cercariae.** F. J. KRUIDENIER, University of Illinois, Urbana.

The structure of the excretory system of the cercaria of *Schistosoma mansoni* and *Tetrapapillatrema concavocorpa* (identification tentative) were analyzed in ultra-thin sections on the RCA-EMU-3 and EMU-2 electron microscopes. Specimens were fixed at O° C with 1 percent osmium tetroxide in a modification of Palade's acetate-veronal buffer solution. Specimens were sectioned on a Porter-Blum microtome.

The cilia of the flame cells originate at a basal plate in close apposition to basal corpuscles in the bodies of the cells proper. Each unit is surrounded by a membrane and separated from adjacent cilia by a fine intermembranous matrix which appears to bind the entire group into the familiar "flame." Each of the cilia, within its individual membrane, consists of 9 equidistant, peripheral, tangentially placed fibers and 1 central pair. The fibers are embedded in a homogeneous to very finely granular matrix. The walls of the excretory tubes of *T. concavocorpa* infold into the lumens as distinct but apparently irregular microrugae that have not been observed thus far in comparable tubes of *S. mansoni*. The epithelial bladder of *T. concavocorpa* consists of very large, highly vacuolate cells. Mitochondria very rarely appear to be distributed in the walls of the excretory tubes and are relatively sparce in the epithelial cells of the bladder of *T. concavocorpa*. They are more numerous adjacent to these organs.

145. **Development of Epidermal Glands and Enclosing Membranes of a Dilepidid Oncosphere.** R. E. OGREN, Dickinson College, Carlisle, Pa. (See abstract No. 35.)

146. **Four Species of *Paragonimus* Occurring in Japan.** I. MIYAZAKI, Kyushu University, Fukuoka, Japan.

147. **Papillae on Schistosome Cercariae.** ALVIN WAGNER, Florida State University.

Surface papillae have been reported on a number of different cercariae, and they appear to be of general occurrence on schistosomes as well as on unrelated forms. Though their function has not been established experimentally. their morphology suggests a sensory role, and they are generally referred to as sensory papillae or sensory hairs.

Papillae have been studied on cercariae of *Schistosoma mansoni*, *Schistosomatum douthitti* and *Ornithobilharzia canaliculata* after fixation by osmium tetroxide fumes and subsequent staining by silver nitrate impregnation. Permanent whole mounts in glycerine can be made after staining in this manner.

In each of the 3 species examined there is some variation in number and position of papillae. a fairly regular, bilaterally symmetrical pattern occurs on the body while on the tail there is greater irregularity. Structures at the anterior end of the cercariae, which have been described as "penetration spines." are stained by this procedure and are believed to be analogous to the other papillae on the body and tail. Most, if not all, of the papillae bear a seta which is usually destroyed during the staining procedure.

The use of these structures as taxonomic characters has been suggested (Vercammen-Granjean, 1951, Ann. Parasit. Hum. et Comp. **26:** 412–414), and it seems possible that cercariae prepared in this manner may serve as type specimens when the adult is unknown.

Permanent mounts of specimens as well as drawings and photographs will be demonstrated.

(Supported by the National Science Foundation and by research grant E-1142 from the National Institute of Allergy and Infectious Diseases, U.S. Public Health Service.)

148. **Some Trematodes from East Pakistan.** W. H. COIL AND R. E. KUNTZ, University of Nebraska, Lincoln, Neb., and U. S. Naval Medical Research Unit No. 2, San Francisco, Calif. (No abstract received.)

149. **The Relation of Climate to the Epidemiology of Gastrointestinal Nematodes of Sheep and Cattle.** NORMAN D. LEVINE, College of Veterinary Medicine, University of Illinois, Urbana.

Successful transmission of nematodes on pasture depends upon a number of climatic

factors, including temperature and precipitation. H. M. Gordon (1948, Austral. Vet. J. **24**: 17–45) introduced the use of bioclimatographs to help visualize the application of these factors to gastrointestinal nematodes of ruminants. In these, mean monthly maximum temperature is plotted against mean precipitation for each month, and the resultant points are joined by a closed curve. Lines are superimposed on these curves to indicate the optimum climatic conditions for the free-living stages of ruminant nematodes. Gordon considered that a mean monthly precipitation of 2 inches or more together with a mean monthly temperature above 65° F provide optimum conditions for the transmission of *Haemonchus*, while the same rainfall and a mean monthly maximum temperature of 55–65° F provide optimum conditions for the transmission of *Trichostrongylus* and *Ostertagia*. It was found in the present study that the optimum temperature range for *Trichostrongylus* and *Ostertagia* under American conditions is 55–73° F.

In this demonstration, bioclimatographs are presented for the Midwest and Southwest, where *Haemonchus* is particularly important; for the Pacific Northwest, where *Trichostrongylus* and *Ostertagia* are particularly important; and for the Southeast and Eastern Seaboard where all 3 are important.

Since these bioclimatographs are based on average conditions over a period of years, and since the weather may vary considerably from year to year. they cannot be used to predict the situation for any single year. In addition, other factors such as soil type, amount and type of vegetation, surface drainage or lack of it, irrigation, etc. may markedly affect the survival of larvae on pasture.

150. **The Life History of a Species of *Philophthalmus* (Trematoda: Philophthalmidae) from the orbit of birds.** A. F. West, Jr. and F. M. Fisher, Jr., Purdue University.

Adults of a species of *Philophthalmus*, obtained by feeding encysted *Cercaria megalura* to chicks, lay eggs which hatch immediately, either in the secretions of the eye or on reaching water. As in the closely related genus *Parorchis*, the miracidium contains a redia which is found free in the heart lumen of *Goniobasis* sp. within a few hours after the snail is exposed to miracidia. The redia produces a second generation of rediae which invade the digestive gland and gonad of the snail to complete their growth and produce cercariae. Cercariae may encyst on any smooth surface and metacercariae have been found on the exoskeleton of crayfish from a stream where infected snails were abundant. The american bittern, *Botaurus lentiginosus*, is added to the natural definitive hosts in southern Indiana given by Fisher and West (J. Parasit. **44**: 648).

151. **Two New Species of the Genus *Xenopharynx* Nicoll, 1912 (Digenea: Plagiorchiidae).** P. N. Chatterji, Zoology Department, University of Illinois.

Four trematodes were collected from the gall bladder of an Indian Cobra (*Naja tripudians*) taken at Sambalpur, Orissa, India, in November, 1957. In 3 of the specimens prepharynx is absent and the testes are horizontally placed. In the fourth specimen a distinct prepharynx is present and the testes are placed obliquely. Thus 2 specimens are represented. Both are members of the genus *Xenopharynx* Nicoll, 1912, resembling the type species, *X. solus* Nicoll, 1912, closely.

The 2 species from the Indian Cobra can be differentiated from all other described species of the genus by the shape and size of their bodies and of their gonads correlated with the oblique or horizontal position of their testes, the presence or absence of a prepharynx, the different ratio of oral sucker: acetabulum and the different levels to which the vitellaria extend posteriorly. Two new species of *Xenopharynx* are, therefore, being proposed for these trematodes.

152. **Avian Schistosomes of the Genus *Ornithobilharzia* at Lake Okoboji, Iowa.** M. J. Ulmer, Iowa State College, Ames, Iowa. (See Abstract #16).

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E. E. TYZZER	1939–42	G. M. KOHLS	1955–56; 1957–
H. W. BROWN	1940–43	R. BARCLAY MCGHEE	1956–
H. W. MANTER	1940–43	P. P. WEINSTEIN	1956–
R. D. MANWELL	1940–43	C. P. READ	1957–
R. P. HALL	1941–44	D. L. DEGIUSTI	1958–
E. H. HINMAN	1941–44	Q. M. GEIMAN	1958–
J. F. MUELLER	1941–44	R. M. LEWERT	1958–
HAROLD KIRBY, JR.*	1942–45; 1951–52	R. E. THORSON	1959–

* Deceased

List of Meeting Places

1925	Kansas City	1934	Pittsburgh	1943	(no meeting)	1952	Ithaca
1926	Philadelphia	1935	St. Louis	1944	Cleveland	1953	Madison
1927	Nashville	1936	Atlantic City	1945	St. Louis	1954	Memphis
1928	New York	1937	Indianapolis	1946	Boston	1955	Atlanta
1929	Des Moines	1938	Richmond	1947	Chicago	1956	Storrs
1930	Cleveland	1939	Columbus	1948	New Orleans	1957	Philadelphia
1931	New Orleans	1940	Philadelphia	1949	New York	1958	Bloomington
1932	Atlantic City	1941	Dallas	1950	Cleveland	1959	University Park
1933	Boston	1942	New York (cancelled)	1951	Chicago		

IN MEMORIAM

Asa C. Chandler (1891–1958) Charter Member and Former President

Howard E. Enders (1877–1958) Charter Member

Herbert G. Johnstone (1903–1959) Member since 1929

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